JAN 2 1918

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LONDON: PUBLISHING OFFICE, 4, LUDGATE HILL, E.C. 4 SUBSCRIPTION per annum, Postage inclusive, in Great Britain, £1 1s. 8d. Canada, £1 3s. 10d. ($5.80); to all other countries, 30s.—NEW YORK: D. VAN NOSTRAND CO., 25, Park Place, New York City. TORONTO, ONT.: WM. DAWSON & SONS, LTD., Manning Chambers. PARIS: BOUVEAU & CHEVILLET, Librairie, Etrangère, 22, Rue de la Banque.
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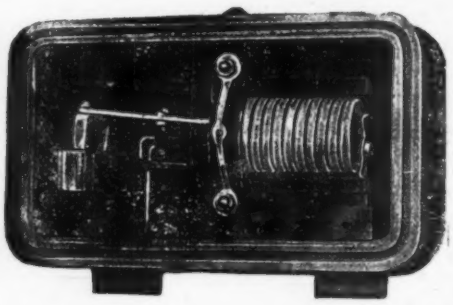

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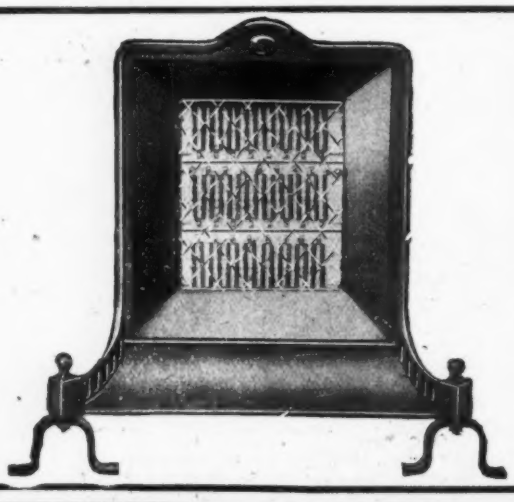

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ELECTRICAL REVIEW.

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The "Electrical Review" is the recognised medium of the Electrical Trades, and has by far the Largest Circulation of any Electrical Industrial Paper in Great Britain.

Subscription Rates.—Per annum, postage inclusive, in Great Britain, £1 1s. 6d.; Canada, £1 3s. 10d. ($5.80). To all other countries, £1 10s.

FOREIGN AGENTS:

ADELAIDE: Messrs. Atkinson & Co., Gresham Street.

AUCKLAND N.Z.: Gordon & Gotch, Albert Street; The Mining and Engineering Review, 31a, Strand Arcade, Queen Street.

BRISBANE: Gordon & Gotch, Queen St.

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ROME: Loescher & Co., Corso Umberto I° 307.

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TORONTO, ONT.: Wm. Dawson & Sons, Ltd., Manning Chambers; Gordon and Gotch, 132, Bay Street.

WELLINGTON, N.Z.: Gordon & Gotch, Cuba Street.

Cheques and Postal Orders (on Chief Office, London) to be made payable to THE ELECTRICAL REVIEW, and crossed "London City and Midland Bank, Newgate Street Branch."

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ELECTRICAL & ALLIED TRADES DIRECTORY

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1917 EDITION.

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THE METRIC SYSTEM.

ON Thursday next the Institution of Electrical Engineers will meet to discuss the metric system, not from the point of view of its merits in comparison with our existing systems, or want of system, but with regard to the difficulties which may be experienced in putting it in operation in the British Empire. Its advantages have been fully demonstrated, not only in the theatre, but also in the workshop, and the Institution, through its Council, has definitely recommended the Board of Trade to hasten its introduction as a compulsory measure; now it is proposed to consider its disadvantages and the best means to overcome them, and we commend the wisdom of this course.

Not even the most zealous advocates of the metric system will pretend for one moment that there are no difficulties to be faced or problems to be solved in carrying out so important and far-reaching a reform; undoubtedly there are some very serious obstacles to its adoption—but none which cannot be negotiated successfully. We take the opportunity to suggest that the question should be approached not with a mandatory attitude of mind, but with the spirit of conciliation, co-operation, and good fellowship, and that every endeavour be made to find satisfactory means of removing or mitigating the objections that will inevitably be raised in various quarters. The public welfare is the consideration which energises us who advocate the compulsory adoption of the metric system, and we most earnestly desire that no man shall suffer in any way from the effects of the change. But equally we trust that even those who firmly believe that it would adversely affect their own interests, will take the broad view and endeavour impartially to judge whether the nation as a whole would benefit by it, and if so, that they also will consider how best their own difficulties can be tackled and minimised, instead of utilising them as obstacles to thrust in the way of the proposed change of system.

The matter is of such great importance to our commercial and industrial future that we hope the speakers in the discussion will not be confined mainly to London residents, but will include many provincial works managers and others who are directly interested in the subject, whether for or against the change; the metrists do not wish to turn a blind eye or a deaf ear to objections—they wish to have the real objections tabled before them, and to join in friendly discussion regarding them. By "real" objections we mean not theoretical or sentimental considerations, but actual practical points such as the question of standards, the conversion of weighing machines and instruments such as gas meters, the supply of merchant rods and bars to metric measures, &c. We know that practical experience on such questions has already been gained, for many of our engineering workshops have for a long time used metric weights and measures more or less extensively—and, incidentally, we may add that they have overcome any difficulties arising from internal sources.

We look forward to a highly interesting and useful discussion, free from digressions involving the "Belgic yard," attempts to modify our existing units, or other obvious futilities, and we should be glad to see a committee appointed for the purpose of collecting and tabulating particulars of all *bona-fide* difficulties with a view to devising ways and means for overcoming them at the minimum of expense and inconvenience.

The question now is not so much *whether* we shall adopt the metric system, as *how* and *when* we shall adopt it; and whether we shall give a lead to the United States in this important matter, or wait—and see ourselves compelled to follow in its footsteps. Against the cost of establishing the system must be set the cost of going on as we are—not only now, but in the strenuous days that are coming—heavily handicapped in our relations with foreign customers and with foreign manufacturers, and in our internal organisation to a degree second only to the former.

It is to be hoped that works managers and others who have had actual experience of the use of the metric system in their workshops, and in their export trade, will come forward and give the results of their experience; for there is no test to compare with the practical test, and certainly no argument so convincing as the irrefutable "I have tried it myself, and *know* that it is good." In this connection we have found it interesting to turn over the replies received to our circular inquiry of September, 1915, when a verdict in favour of the metric system was returned by the handsome majority of four to one; of the many firms that were using the metric system in their shops, a large proportion were enthusiastic advocates of its general adoption, and not one reported any special difficulty in applying it. Further, of those who dissented from its compulsory introduction, not one stated that he had tried it unsuccessfully. We are inclined to believe, as the result of this and other evidence, that the difficulties which bulk so large in the distance are found to melt away when the matter is grappled with at close quarters. In all our reading of the arguments of anti-metric writers, we do not recollect a single instance of difficulty in teaching the workmen to use metric units—they are so simple that anyone who can read an English scale can use a metric scale with greater ease.

One of the commonest mistakes in dealing with this subject is the assumption, quite groundless, that English units cannot be converted into metric without the use of several places of decimals. We went to considerable trouble in 1915 to show beyond cavil that, as the millimetre is a much smaller unit than the inch, drawings figured to the nearest millimetre could not be more than 20 mils in error; if figured to the tenth of a millimetre, the error was less than 2 mils, which is about the average error of measurement met with in the workshop; and if figured to the hundredth of a millimetre, the error (less than 2/10 mil) could only be distinguished by refined methods of measurement such as are rarely employed in the workshop. Jigs and gauges need no alteration whatever. Moreover, it is seldom possible to arrange for more than a very few of the dimensions of a metal part to be simple figures in inch measurements, and there is, therefore, no reason to cavil at a corresponding inability in the case of the metric system (though, owing to the inch containing 25 mm., integral mm. dimensions should occur about 25 times as frequently).

Many other arguments were advanced by our correspondents and by ourselves in our long series of articles on this subject, which will be found in our issues of October 15th to November 26th, 1915, and in that of March 23rd, 1917, together with evidence derived from actual workshop experience in various countries.

We recently read in our American namesake that as a result of war orders, factories all over the United States were working to metric measurements, and thousands of workmen were becoming familiar with the centimetre and the gramme. The validity of the argument that the adoption of the metric system involved serious difficulties in the adaptation of mechanical appliances to a different scale had been quite destroyed by the comparative ease with which adjustments were made to suit the new conditions, and our contemporary urged that "right now" the metric system should be made the national as well as the international language of commerce and industry. We think so, too.

Water Power in Sweden.

The Year-book for 1916 of the Swedish Chamber of Commerce for the United Kingdom contains an interesting article on the Svenska Vattenkraftforeningen, or Swedish Water-Power Association, the aims of which are to promote the national economic utilisation of the water-power resources of Sweden, and especially to attain a precise knowledge of the country's resources in available water power, to ascertain the best means of turning such resources to account from a technical and economic point of view, to promote and assist schemes for the conservation and regulation of lakes and rivers, and, generally, to apply the experience gained both in Sweden and abroad in the solution of such questions.

The utilisation of the abundant water power of Sweden has from year to year become of greater importance as a lever in the extension of its industry and development. Until, however, the Association was formed, towards the end of 1909, there was no uniformity in the methods adopted for dealing with the problem. One great drawback experienced was the over-rating of the water power as a direct source of income and subject for taxation, while another was a movement towards limiting the rights of strandowners to the disposal of the water, under cover of which the water-power utilisation industry had up to then been developed.

Since its establishment, the Association has had numerous opportunities for activity, among the matters dealt with having been the following: Proposals to the Riksdag, or Swedish Parliament, for the administration of certain waterfalls belonging to the State; for a law regarding waterfall rights; for ensuring the fulfilment of contracts for the delivery of electric power; for the introduction of concession laws relating to waterfalls and power stations; and, finally, the framing of a new water-right law.

To increase the knowledge of the water power in Sweden, the Association has compiled comprehensive statistics, and has issued special survey maps based thereon. It has also arranged water-power exhibitions, where the Swedish water-power technicalities and the progress of the Swedish water-power industry have been illustrated by numerous collections of drawings, photographs, statistical tables, &c. In recent years, the Association, which now comprises 260 private members, 100 commercial undertakings, 12 societies and other corporations, and six foreign societies and corresponding members, has specially endeavoured to prepare for an increased consumption of water power, with the view of lessening Sweden's dependence on fuel from abroad. By means of its information department, the Association publishes, as occasion arises, a series of pamphlets, about 80 having up to the present been issued. Lectures are also given and papers read before technical societies, chambers of commerce, &c., in the country with the view of disseminating information regarding water power and its utilisation.

MODERN ARC LAMPS AND INCANDESCENT LAMPS.

Ever since the "half-watt," gas-filled tungsten filament lamp was first placed on the market, it has been a subject of discussion to what extent the filament lamp could economically replace the arc lamp. Many writers have asserted that one lamp or the other would ultimately attain to virtual supremacy, but we have maintained consistently that there is, and will always be, a field of application for both types. This view is supported by a comparative study due to Heyck* (chief engineer to Körting & Mathiesen). The author's attitude appears to be impartial, and he gives many data hitherto available only in scattered form, if at all.

Special types of arc lamp, such as those used for projection, reproduction or copying processes, "daylight" lamps, and searchlight arcs, are in a practically unassailable position. On the other hand, arc lamps burning plain carbons and small enclosed arc lamps are practically obsolete for general lighting purposes. The types of arc lamp concerning the prospects of which, in competition with high-power filament lamps, it is most difficult to reach a decision, are open lamps burning impregnated carbons mounted side by side, and enclosed lamps burning impregnated carbons mounted one above the other. Considerations which have practically established the supremacy of half-watt lamps over the smaller and less efficient types of arc lamp are :- The lower first cost of the filament lamp; the simpler installation and maintenance of the latter; the steady "white" light given by the filament lamp and the fact that the latter can be used singly (not in series connection) even where a comparatively small lighting unit is required and the supply voltage is high. Also a filament lamp of higher or lower candle-power can be substituted easily for another; this practice may easily be abused, but it is often very convenient. Some forms of arc lamp give a better approximation to white light than the tungsten lamp, but none can claim equal steadiness of lighting, and the difference in colour is not often a determinative factor.

The arc lamp burning plain carbons costs more than the tungsten filament lamp both in direct and indirect working costs. The cost of carbons has to be set against the cost of bulb replacements, and the efficiency of the half-watt lamp compares favourably with that of the ordinary plain carbon arc, or that of the long-hour enclosed arc. When used in a suitable fitting the "half-watt" lamp consumes 0·55 to 0·9 watt per C.P.† This may be compared with 0·68 to 1·0 watt per C.P. for D.C. plain carbon arc lamps of the open type used two in series on 110-volt supply; or with 0·57 to 0·73 watt per C.P. for similar lamps used three in series on 110-volt supply. Enclosed arcs with plain carbons consume 0·8 to 1·1 watt per C.P. if used singly on 110 volts; and from 0·7 to 0·8 watt per C.P. if used three in series on 220 volts.

Plain carbon arc lamps can only be considered for indoor lighting purposes at the present day (the flame arc holding the field for external arc lighting) and in indoor illumination the power expenditure per foot-candle per square foot of floor area is a more important factor than the watts per candle-power. On the basis of watts per foot-candle per square foot, the half-watt lamp compares very favourably with the plain carbon arc, whether for direct, semi-direct or indirect lighting. For purposes of comparison, the data in Table I are useful, these being averages for a room 33 × 20 ft., with white ceiling, white frieze and grey walls. The arc lamps are supposed to be provided with opal globes, and the data for half-watt lamps assume a 300-watt lamp with an opal globe for direct lighting and "Kandem" fittings for semi-direct and indirect lighting:—

TABLE I.—Average Watts per Candle-foot per Square Foot of Floor.

Type of lamp.	Watts per candle-foot per square foot (or per candle-metre per square metre).		
	Direct lighting.	Semi-direct lighting.	Indirect lighting.
Plain carbon arc : open type.			
D.C. : two in series on 110 v....	0·17	0·23	0·18*
D.C. : three in series on 110 v....	0·11	0·16	0·25
A.C. : connections not stated...	0·25	0·27	0·36
Plain carbon arc : enclosed type.			
D.C. : singly on 110 v..... ...	0·20	0·30	—
D.C. : three in series on 220 v....	0·14	0·23	—
Half-watt lamp (300 watts) ...	0·12†	0·11	0·14

* Burning with positive carbon beneath; only practicable with two lamps in series and not with enclosed arcs. † Opal globe.

The data in Table I indicate, on the basis which is of primary importance in lighting interiors, a surprising economy in the gas-filled tungsten filament lamp, particularly in semi-direct lighting. The fact that *semi-direct lighting is cheaper than direct lighting* (or, for practical purposes, equally cheap) where half-watt lamps are used and the ceiling is white, is due to the fact that this type of lamp emits practically equal quantities of light upwards and downwards. Fig. 1 shows a typical candle-power curve for a bare 500-watt half-watt lamp of 695 m.s.c.p.; 660 m.h.-s.c.p. (upper); and 730 m.h.-s.c.p. (lower). The cap of the lamp offers a certain obstruction to up-going light. The remainder of the latter, when the lamp is used in an opal globe for direct lighting, is reflected downwards by a shade with an efficiency of reflection of 50 to 60 per cent. Generally, light so reflected has still to pass through the opal globe, and is thereby weakened another 15 to 25 per cent., so that only 40 to 50 per cent. of the light sent out by the lamp above the horizontal is available for downwards illumination. On the other hand, light going upwards from a semi-direct fitting is reflected downwards by a white ceiling with practically the same loss as is occasioned by the enamelled shade of a direct lighting fitting, but after reflection from the ceiling, light is subject to no globe loss, hence semi-direct lighting (using globe lamps) is as efficient as, or even a little more efficient, than direct lighting. The lower efficiency of indirect lighting is due to light originally sent downwards having to submit to double reflection (from the fitting and from the ceiling) before it proceeds to the working plane. It will be seen, however, from Table I, that indirect lighting is only about 20 per cent. dearer than direct lighting and 30 per cent. dearer than semi-direct lighting; it is *not* twice as dear as direct lighting.* Figs. 2—4 show typical polar curves of candle-power for direct, semi-direct, and indirect lighting units using half-watt lamps.

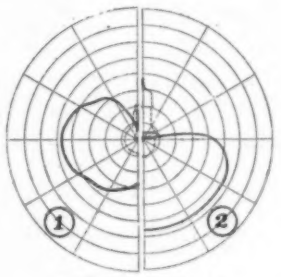

Fig. 1. Fig. 2.

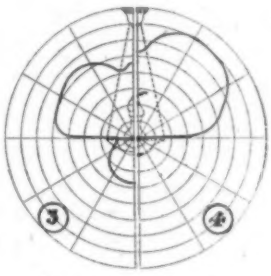

Fig. 3. Fig. 4.

Semi-direct lighting has become very popular during the past few years, and obviously not without sound justification, in respect of high efficiency. Lest it should be objected that everything depends on the ceiling being cleaner than it can be kept in practice, it may be noted that

* Zeitschrift des Vereines Deutscher Ingenieure.

† Here and hereafter reference is to *mean lower hemispherical British candle-power*, unless otherwise stated.

* Table I assumes equal illumination in each case, but it is generally necessary to provide higher mean illumination with indirect lighting than is needed when there is a high percentage of direct illumination. This necessity makes indirect lighting relatively more costly than indicated by Table I.—[Eds.]

the figures in Table I are based on tests made beneath a ceiling which had not been whitewashed for five years. Electric lamps themselves do not soil the ceiling, and in living rooms, offices, and workshops, where no very dirty work is performed, it is sufficient to whitewash ceilings every two years in order to maintain the efficiency of semi-direct or indirect lighting. It is much more important that the lamp bulb and reflecting surfaces of the fitting be kept clean; due to the brisk local circulation of air maintained by the heat of the lamp, dust accumulates fairly rapidly on these parts, and to prevent its becoming "burnt on," and causing great loss of light, the lamp and fittings should be cleaned regularly (generally at intervals not exceeding one month).

A point which is not unimportant in interior work is that glow lamp fittings can be varied to a far greater extent than arc lamps, in order to harmonise with architecture and decorations.

(To be continued.)

THE EDUCATION AND TRAINING OF ENGINEERS.

By "RADIX."

(*Continued from page* 508.)

The attempts of Labour to coerce payment on the highest possible scale by taking advantage of the necessities of Capital, and the efforts of Capital to grind as much as possible out of Labour without regard to the fact that the labourer is a human being, have resulted in measures being adopted by both sides which "kill the goose that lays the golden eggs." The canker of individualism has eaten into our whole social system.

A skilful dialectician may, no doubt, be able to make out a case for individualism, but in the long run the man who seeks to grind his own axe only, ends either by cutting himself badly, or by falling a victim to the natural feelings of rancour aroused in those who have suffered by his inconsiderate egotism.

Is it not the fact that nowadays the majority of us are more concerned with our legal than with our moral position? Is it not general experience that if a man is honest, it is—more often than not—because he is too great a fool to be anything else? Do we not find that the number of business men who "understand legal liability and limited liability, but know nothing of moral liability," is increasing? Is not everyone familiar with the aphorism "truth is sometimes met with in this world, even in an affidavit"? And does not one's personal experience of affidavits show that there is solid foundation in fact for this seemingly cynical utterance?

Trade Unions have introduced rules and regulations which tend to create in the minds of members (and particularly young members) the habit of thinking only of their rights and privileges, and ignoring the fact that duties and responsibilities are necessary concomitants of rights and privileges—in other words, to destroy instead of to preserve the "nice equilibrium between the subjective and the objective faculties." That a journeyman mechanic should receive the same rate of pay whether he be a highly skilled man with 20 years' experience or whether he be an apprentice just out of his time is a manifest absurdity, and tends to kill all desire to excel. On the other hand, the principle adopted by some employers to "overload the willing horse and say nothing" is equally pernicious. In either case the mechanic is deprived of any stimulus to take pride in his work, or to improve in his art. The standard of skill is lowered, and the factor of conscientiousness dwindles towards zero. This reacts upon the productivity of the nation, and constitutes a serious handicap in national progress.

The word "bargain" has come to mean an exchange in which one party obtains an undue advantage. In the original sense of the word, the essence of a bargain was that each party rendered to the other a just equivalent. Were this principle more rigidly observed it is safe to say that nine-tenths of the sources of dispute between Capital and Labour would disappear.

Trace any human action back to its source and we finally come to an act of volition. In fact, we have no experience of any cause but Will.*

Leaving on one side any metaphysical speculations as to the origin or function of Will, we are face to face with the indisputable fact that in the ultimate analysis the action of a man placed in supreme authority is controlled, humanly speaking, by nothing but his Will. Is it not the fact that, so far as human beings generally are concerned, "goodness" or "badness" is a function of ability to resist temptation? Do not the numerous cases of misappropriation of trust funds by men who enjoyed the highest reputations for honesty and integrity bear this out? What is there to impel a man to do right simply because it *is* right, except the possession of an invincible moral sense? And is the inculcation of the imperative necessity of observing the moral law accomplished by the training of the rational faculty alone, be it in the direction of scientific research or of mechanical skill? We surely do not need any more convincing object-lesson in the futility of any attempt to base the moral law upon reason only, than is found in the inverted moral sense of the German Empire of to-day, as exhibited in the utterances of their leaders of thought and in their methods in warfare.†

During the discussion at the meeting, Mr. Berriman made a point of the great advantage that would accrue from the cultivation of relations of friendship between masters and men; Prof. Dalby said something to the same effect; Mr. Longridge caused a gasp of amazement by the use of the word "religious" in his speech; Sir John Wolfe Barry insisted upon the necessity of raising the moral tone; Mr. Hadow said that "we needed not only skilled men, but *good* men."

All very true, but this will not be accomplished if reform in the education and training of engineers is confined to means for raising the standard of skill and for imparting a knowledge of theory. The attainment of a high degree of mechanical skill will not impel a mechanic to give a fair day's work for a fair day's pay, nor will the possession of an engineering degree impel an employer to pay a fair day's wage for a fair day's work. Education (or

* "It seems absurd one white man sitting in the house of the King of hundreds of thousands of subjects and dictating, and not only that, but being attended to and obeyed. And this is the power the white man has, what it is I can't say, but whatever it may be, it is that power, and not all the black troops we may raise, that enables us to stay in the country. It is a very curious thing to think over, but here we hold this vast country (and it is the same, of course, all the world over) simply by Will power or whatever it may be termed; by nothing else, for the natives could rise up and drive every white man into the sea to-morrow if they wished." —(*Extract from a letter written at Illorin, Nigeria, by David Wynford Carnegie.*)

† In this connection, the words of Cardinal Manning, written about 40 years ago, are worth recalling:—"A fatal extinction of supernatural light, the aberration of false philosophy, the inflation of false science, the pride of unbelief, and a contemptuous scorn of those who believe, are preparing Germany for an overthrow or for suicide."

The event has shown these words to have been prophetic. In the September issue of the "Nineteenth Century and After," Mr. Ellis Barker, a well-known writer on Germany and the Germans, concludes an essay, entitled "How Education has Degraded the German Character," with these words:—"Education, far from enlightening the German nation, has blinded, debased, and dehumanised it."

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what passes for such to-day) and morality are not correlatives. "The belief in the moralising effects of intellectual culture, flatly contradicted by facts," says Herbert Spencer, "is absurd *a priori*. . . . One who should by lessons in Latin hope to give a knowledge of geometry would be thought fit for an asylum; and yet he would be scarcely more irrational than are those who by discipline of the intellectual faculties expect to produce better feelings." (Study of Sociology, Chap. VIII, p. 363.)

It may be said that all this is not the business of the Committee it is proposed to appoint. Possibly not—directly. But it has got to be somebody's business because just as "the modern world has recently learned that it is useless to try to educate a child that is not fed," so it will prove useless to try and turn out "*good* men as well as skilled men" unless the men possess the potentiality of goodness as well as of skill. You cannot make a silk purse out of a sow's ear.

The evils from which humanity is suffering to-day are largely traceable to the persistent neglect, throughout generations, of the training and development of Will and character in the young. At present the moral training of our children, our young men, and young women, gives some of us rather less concern than the selection of our daily food.

(To be continued).

PYROMETERS AND PYROMETRY.

The Faraday Society opened their session on November 7th, meeting in the rooms of the Royal Society of Arts, when a large gathering contributed to the success of the general discussion on "Pyrometers and Pyrometry," which filled—and more than filled—the evening's programme. Owing to the regretted absence of the President, Sir Robert Hadfield, to whose initiative the discussion was due, the chair was filled, appropriately enough, by Sir Richard Glazebrook, C.B., F.R.S., Past-President, the Director of the National Physical Laboratory, where so much valuable work on heat and its measurement has been carried out almost since its foundation. This early work was referred to by the Director in the interesting contribution to the discussion with which he opened the proceedings. In those early days the old Kew thermometer represented the national means of measuring temperature, and it was due to Sir Andrew Noble that Dr. Harker was able to begin the investigation of the relation between the air thermometer and Callendar's platinum resistance thermometer. It was not until 1913 that the standardisation of higher temperatures was attempted, and this aspect of the subject was dealt with by Dr. Ezer Griffiths and Mr. F. H. Schofield. It had been arranged to hold a conference at Berlin in September, 1914, to introduce an international scale of high temperature, up to and possibly beyond 1,300 deg. C., but under the circumstances an agreement between the Washington Bureau of Standards and the National Physical Laboratory was all that had been reached. Sir Richard gave some striking illustrations of the importance of exact high temperature measurements to modern industry. It was found, for example, that in a particular heat treatment process 40 or 50 per cent. of the steel articles had to be rejected, because the temperature of quenching had only been judged by the skill of an experienced workman instead of measured by a pyrometer.

Pyrometer Standardisation.—The paper by Griffiths and Schofield already referred to gave an account of methods at present in use at the National Physical Laboratory. The standard scale of temperature is thermodynamic, but in practice the problem of standardisation resolves itself into an empirical calibration of the pyrometer against a gas thermometer, but the comparison not being always a direct one takes place through the following stages:—

1. Comparison of gas thermometer with a thermoelement.
2. This thermoelement is employed to determine the freezing points of a number of pure metals.
3. The freezing-point determinations are used by the observer who wishes to calibrate a pyrometer for the standardisation of his thermoelement, who then compares the pyrometer and thermoelement under suitable conditions.

In practice the constant-volume hydrogen thermometer is used to realise the scale between 0 deg. C. and 100 deg. C., and calibrated against this, but extending over the range between the freezing point of mercury (38.88 deg. C.) and the boiling point of sulphur (444.5 deg. C.), the platinum resistance thermometer is employed. The paper proceeds to give the best determinations now available of the fixed points on the thermometer scale up to the melting point of copper (1,083 deg. C.). Above this temperature few investigations have been made with the gas thermometer, but Day and Sosman, using a rhodium-alloy bulb, have arrived at 1,549 deg. C. as the melting point of palladium, and by extrapolation 1,755 deg. C. as that of platinum. Up to 1,550 deg. Day and Sosman's "fixed points" are usually accepted as standards, but above that temperature the scale should be extended on the basis of the radiation laws.

Mr. John Rhodin, in the discussion, raised the interesting point as to whether it would not be better to base the whole of our thermometric scale on the laws of radiation, which have a sound theoretical basis. Messrs. Griffiths and Schofield went on to describe the apparatus employed for calibrating the thermometric pyrometer by means of the accepted "fixed points," and they discussed in some detail the sources of error to be looked for and avoided. Finally the calibration of total radiation and optical pyrometers was dealt with, the electric furnaces used for the purpose, an example of which was exhibited at the meeting, also being briefly described.

Recent Developments in Pyrometric Apparatus.—Of the group of papers describing recent forms of pyrometers and of apparatus for obtaining high temperatures, the most interesting were contributed from America. That sent by Dr. E. F. Northrup was particularly illuminating and suggestive. After pointing out the objections to existing types of electric furnaces, particularly those used for fusing chemically-pure products requiring very high temperatures, he laid down the condition that in the ideal furnace the heat should actually be produced *within* the crucible. This requires an electric induction furnace, but for various reasons which are set forth

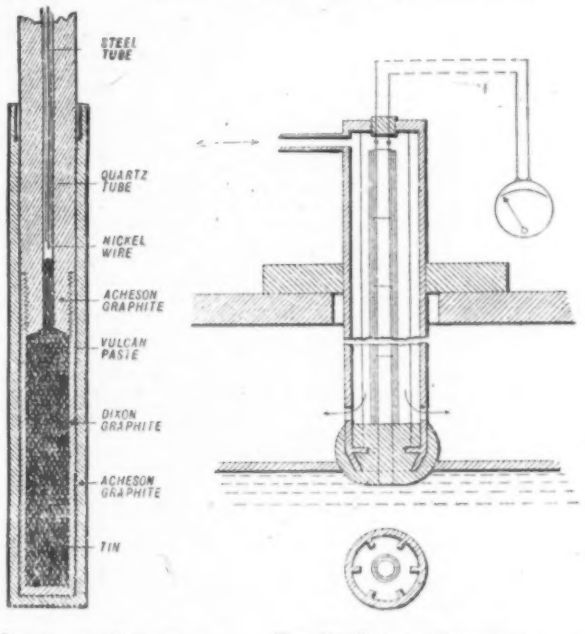

Fig. 1.—Tin Pyrometer. Fig. 2.—Rogers Pyrometer.

it must be a furnace obtained without the use of iron. Such a furnace, of 20-kw. capacity, Dr. Northrup has succeeded in constructing by employing high-frequency currents (up to 25,000 cycles per second at 7,000 volts) in an induction coil of some 50 turns to induce very large currents in the crucible—walls or contents—which it surrounds. The primary currents are oscillatory, and produced from the discharge through condensers of a two-phase, 60-cycle, 220-volt supply. The apparatus seems complex; in reality it is very simple, and in peace times—as pointed out by Mr. E. H. Rayner—is an ordinary marketable wireless outfit of somewhat high power. The thermal efficiency of the 20-kw. furnace is as high as 60 per cent.; it will melt 45 lb. of brass in 35 minutes, and the vacuum type will bring a 14-cm. diameter graphite furnace filled with tin or glass to a temperature well over 1,600 deg. C. in 40 or 50 minutes. Dr. Northrup was in hopes of attaining 2,000 deg. C., and the building of furnaces of large units was in contemplation. The furnace, which is made by the Ajax Metal Co., of Philadelphia, was most favourably received by those competent to judge, and the type was considered to have a future before it. Certainly a furnace in which metals like tungsten and its alloys can be melted *in vacuo*, free from carbon, is one which metallurgists keenly desire.

Dr. Northrup's latest appliances for *measuring* high temperatures were no less interesting. Up to 1,300 deg. C., temperatures in any kind of atmosphere can be accurately measured by means of well-constructed platinum-rhodium thermocouples, but the potentiometer on which the e.m.f. is

measured must be of a robust, portable type. Such an instrument, used in connection with a direct deflection millivoltmeter (that can be calibrated to degrees), and known as the "Northrup Pyrovolter," was described in the paper. It being a deflection instrument, its accuracy and permanency depend upon the permanence of a permanent magnet rather than upon that of a standard cell, and as the voltmeter is introduced into the circuit after balance has been obtained in substitution for a copper coil of equal resistance, its temperature coefficient introduces no errors. We believe that in this country Dr. Rosenhain has also designed a workshop type of potentiometer.

A somewhat similar type of potentiometer was described in a paper communicated by Mr. Richard P. Brown, of Philadelphia. In this a direct reading on a high-resistance millivoltmeter from the thermocouple is measured by comparison with an equal voltage from a dry-cell circuit. The temperature coefficient of the meter is likewise eliminated by furnishing a copper resister in the meter equivalent to the copper or aluminium of the coil. The high resistance of the voltmeter, up to 1,000 ohms, is secured by reducing the weight of the moving element to a minimum. It is made of an aluminium alloy wire 0.003 in. dia. enamelled for insulation.

Thermoelements and High-temperature Thermometers.—Mr. Brown tells us that in the States nitrogen thermometers, taking the form of a copper bulb actuating through capillary tubing an expansive spring, are considered the most satisfactory instruments to use up to 425 deg. C. Mr. J. C. Rhodin drew attention in this connection to the Wiborgh pyrometer, which was successfully used for controlling the temperature of an air blast-furnace up to 800 deg. C. This was a gas thermometer in which a known quantity of air under a known pressure was pressed into the bulb. For temperatures up to 1,100 deg. C. a base-metal thermocouple, usually compounded of 90 per cent. nickel and 10 per cent. chromium, and 98 per cent. nickel and 2 per cent. aluminium, is generally employed in America. For temperatures up to about 1,300 deg. C. platinum and rhodium thermocouples are in vogue in America as well as in this country, but they are unsatisfactory, Dr. Northrup tells us, in a reducing atmosphere above about 145 deg. C. A thermocouple of tungsten-molybdenum though giving a small E.M.F., can be used to measure extreme temperatures if protected from hot gases.

For temperatures up to nearly 1,700 deg. C., Dr. Northrup recommends the use of molten tin (boiling point 2,270 deg. C.) as the pyrometric substance, and he describes a form of molten-tin thermometer with a bulb and stem of graphite, in which the height of the column is determined by electrical contact. A cross-sectional view is shown in the accompanying figure (p. 533). Dr. Northrup urges investigations into the possibilities of molten tin for extending the fundamental temperature scale above the limits of the gas thermometer.

Base-metal thermocouples were also discussed by Mr. C. R. Darling and Mr. G. E. M. Stone. Mr. Darling and Mr. A. W. Grace have shown that in general the E.M.F. of a couple is not affected by the fusion of one or both of its elements, and if, therefore, provision be made for either element to fuse without breaking the circuit, the employment of such couples is feasible up to 1,500 deg. C. Mr. Stone's paper, which was of considerable practical interest, dealt with remediable causes of unreliability encountered in thermoelectric pyrometry, especially in base-metal systems. A very common source of trouble could be traced to the low terminal resistances of instruments.

In work where high accuracy is desired, the temperature of the cold junction needs careful watching, and Mr. R. S. Whipple advocated burying this some 10 ft. or more beneath the floor, protecting it by a metal sheath filled with bitumen or powdered magnesia. Such buried thermocouples are being successfully used in works practice.

One great difficulty in using thermocouples at high temperatures is the protection of the couple from direct contact with the molten metal of the furnace under measurement. Dr. F. Rogers boldly cuts the Gordian knot by letting the tips of his elements—not otherwise united—actually dip into the molten metal (fig. 2). Only a very short immersion is necessary for a steady reading, so there should not be unduly rapid deterioration of the expensive wires composing the elements. The method deserves a good trial. Incidentally, we may refer here to a rough workshop method Mr. S. N. Brayshaw uses for standardising pyrometers, in which he melts a 60/40 copper-tin alloy—a eutectic of wonderful stability—in a deep graphite crucible in an atmosphere of coal gas, covering the molten alloy with charcoal. This gives a "fixed point" of 730 deg. C., which happens to be the Ac transformation point of a much-used 1.1 per cent. carbon and 0.5 per cent. tungsten commercial steel.

Automatic-control Pyrometers.—Several speakers touched on this important subject, and Mr. C. E. Foster expressed a widely-held view, which manufacturers should take note of, that the automatic control of a furnace by means of a pyrometer, although presenting many difficulties, was a practical proposition with a future before it. Mr. S. A. Main, of Messrs. Hadfields, Ltd., exhibited a Brown control instrument for operating an electric furnace. In this a nickel-chromium alloy thermocouple actuates a high-resistance millivoltmeter. A small motor or clock depresses the instrument pointer every 10 seconds, and thus brings together two contacts which, working through relays, actuate the switch controlling the furnace current. A valve of a gas or oil furnace can be similarly controlled, and the principle may be applied to signalling pyrometers showing red, white, or green lights according as the temperature is too low, within limits, or too high.

(To be concluded.)

THE NITROGEN PROBLEM.

The war has forcibly brought home the vast service that science can render to trade and industry. In almost every branch of business the chemist and scientist can reduce costs, increase profits, and open up new fields for the merchant to conquer. Research incidental to the conduct of the war has shown that this applies particularly to those industries dependent on nitrogen compounds. Forced by circumstances to face the problems connected with the provision of ammonia and of nitric acid by the newer synthetic processes, we are well on the way, thanks to the valuable work of the Nitrogen Products Committee of the Munitions Inventions Department, to solutions that promise permanent benefit to the agriculture and commerce of Great Britain, apart from the immediate assistance rendered towards the successful prosecution of the war.

Nitrogen compounds are essential for explosives, and in the form of fertilisers for agriculture. The world's consumption for agricultural purposes almost doubles every 10 years; in 1913 it was no less than 2½ million tons of Chile nitrate, and about 1¼ million tons of sulphate of ammonia. As long ago as 1898 Sir William Crookes predicted a shortage in the world's wheat supply, and urged the vital importance of finding other sources of nitrogenous fertilisers in view of the fact that the natural deposits of Chile nitrate were limited in quantity. Sir William himself experimented in obtaining nitrogen from the air, in which it exists in unlimited quantities. Other countries appreciated the possibilities thus indicated, and set to work on the problem of nitrogen fixation. Norway, being at an advantage with cheap water power, adopted the arc process, which produces nitric acid direct from atmospheric nitrogen and oxygen, but only by an enormous consumption of power. Germany, on the other hand, concentrated, in the main, on bringing to a commercial success a process worked by Prof. Haber for producing ammonia by the union of hydrogen and atmospheric nitrogen at extremely high pressures and at an elevated temperature. We, however, with whom the idea of nitrogen fixation originated, did nothing, the ammonia recovered at gasworks and coke ovens being practically the only form of combined nitrogen produced in this country.

When the war began, the Central Powers, by extending their established nitrogen fixation processes, and by developing others, such as the cyanamide process for the production of nitrolim or ammonia, and the oxidation process for converting ammonia into nitric acid, became self-sustaining. Although the command of the seas enabled us to import from Chile all the nitrate of soda we needed for munitions and agriculture, and so escape the consequence of our scientific neglect, the beginning of the submarine campaign in February, 1916, forced us to review the position.

In June, the Nitrogen Products Committee was set up under the chairmanship of the Comptroller of the Munitions Inventions Department of the Ministry. Before the Committee lay the difficult task not only of discovering the working details of some of the more important processes which are carefully guarded by the foreign firms who are working them, but of making the processes commercially practicable. Because of the pre-eminent position held by the Haber process in Germany, where the economic conditions as regards coal supplies and the comparative absence of water power are similar to those here, and because it was plain that the research would be especially difficult owing to our limited knowledge of the process, attention was first directed to the problem of the production of synthetic ammonia. The Committee then turned its energies to bringing to a commercial stage the ammonia oxidation process for producing nitric acid from gasworks and other forms of ammonia, a process which had not hitherto been practised in England, although worked to some extent on the Continent.

The fruitfulness of the Committee's inquiries led to the issue of an interim report in February, 1917, and on this the Minister (Dr. Addison) decided to take action, among other things upon the ammonia oxidation process. The Explosives Department has since taken over the task of establishing the process on a commercial basis. Manufacturers interested in ammonia oxidation met the Comptroller and the research staff, with the practical outcome that in several of our largest chemical works the process is being introduced to take the place of the nitre-pots used in the making of sulphuric acid by the Chamber method. Seeing that before British chemists concentrated their attention on this problem the annual consumption of Chile nitrate for the purpose in question was 18,000 tons, the saving of shipping space by the adoption of the ammonia oxidation process may become very material.

The investigation of the Haber process has involved the

solution of several difficult chemical engineering problems, as was to be anticipated in operations necessitating the compression and manipulation of gases at extremely high pressures. The whole of the conditions governing the process have been thoroughly studied, with the result that a method of working has been devised whereby the output of ammonia per unit of plant has been increased to a figure which, as far as is known, has never been approached, even in Germany, the home of the process. A semi-technical Haber unit is now in operation, and is providing data concerning the few further details to be elucidated prior to the erection of a full-sized unit. As an outcome of this synthetic ammonia research work, a process has been discovered for the preparation on a large scale of the purest hydrogen, and the promise displayed in small-scale work is now being put to the test by semi-commercial trials.

Although the Committee has concentrated particularly on processes valuable as war measures, the possibilities of nitrogen fixation in relation to agricultural and commercial requirements after the war have not been lost sight of. The manufacture of cyanamide or nitrolim, a valuable fertiliser, has been investigated by a deputation which proceeded abroad for the purpose. It is not unlikely that the industry may be established in this country to meet the demand for fertiliser that is anticipated as a result of the Board of Agriculture's new policy, which will bring several million additional acres into cultivation.

To establish certain nitrogen fixation processes on a sound basis cheaper electric power will be imperative. An inquiry has been made as to the possibility of cheapening the production of electric power from coal by the use of methods permitting of the recovery of ammonia, fuel oils, and other by-products hitherto wasted when raw coal has been directly used. Schemes for the utilisation of various undeveloped water powers in this country for electric power production have also been examined. The survey of a particular drainage area has recently been completed, and has revealed a potential source of 40,000 electrical horse-power in an important industrial area. Finally, the Nitrogen Products Committee has investigated the probable requirements of this country for nitrogen compounds, and has gone carefully into the probable costs of manufacture by the various synthetic and non-synthetic methods in the light of experience in allied industries.

Moreover, in order to review the nitrogen problem as it affects the Empire, the Committee has got into direct communication with official representatives of Australia, Canada, New Zealand, South Africa, Egypt, and India. It is in touch, too, with Allied countries; France, Italy, and Russia have representatives acting in liaison with the Inventions Department on the nitrogen problem.

The final report of the Committee, which it is hoped will not be long delayed, will form an impressive record of scientific industry and resource, bearing testimony to the truth that Great Britain, once she is roused, is equal to any emergency.

CORRESPONDENCE.

Letters received by us after 5 P.M. ON TUESDAY *cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.*

British Methods in Foreign Trade.

A letter from India recently appeared under the above heading in some of the electrical papers from "Trumpeter," and I crave leave to give a small example of how things should not be done.

In September, 1916, when on the point of returning to India, I personally gave an order to a very well-known London firm for an electric toaster, paying the cost there and then—some 22s., I think. I was, of course, fully prepared for delay, as none of these were in stock at the moment. Dispatch was advised a few months ago, and the toaster arrived in September, 1917. I used it at breakfast for exactly six days before it burnt out, the pressure being correct (220 volts) within a small margin. But the point is that *it would not make toast*. The elements are placed at the two sides with a wide vertical strip in between, so that no ingenuity could prevail on the bread to toast down the middle. The engineer of the Simla supply, whose electric fires and water heaters are ahead of most types I have met, re-wired the device for me in a sensible manner, and now it makes good toast.

J. W. Meares.

Simla, *October 13th*, 1917.

The E.T.U. or the A.E.S.E.?

I am desired by the members of the Marylebone Branch of the National Amalgamated Union of Enginemen, Firemen, and Electrical Workers to call the attention of "Progress" to the fact that there are about 11 or 12 Unions catering for the employés of the generating stations. Up to the present moment Mr. Meakin is the only trade union agent known to us who took the initiative in trying to get a base rate for London and suburbs in the power stations. Something like two years have passed since inquiries were made in a certain direction on the part of the N.A.U.E. which ultimately led to the matter being placed before Sir Geo. Askwith. The official figures submitted were so startlingly diverse with respect to the wages of the generating and distributing staffs of 10 leading power stations that the Marylebone Branch decided to commission Mr. Meakin to make inquiries all round. He started straight away, and the task is not yet completed. We would like to ask why another union is to be formed only to go over the same ground as we have traversed? To put an end to this piecemeal method of working, it has been suggested by an official of another trade union that a round-table conference of all the secretaries of the trade unions interested should be arranged. I make the suggestion as it was given out, and perhaps some of your readers would like to offer opinions through your columns.

J. Vincent,
Branch Secretary.
The National Amalgamated Union of Enginemen, Firemen, Mechanics, Motormen and Electrical Workers.

London, N.W., *December 3rd*, 1917.

I read with great interest the letter from "Progress," but before starting a new trade union would it not be just as well for some of the older ones to declare their policy? In common with many others, I have been asked to join the E.T.U., but I am in doubt on one vital point, viz., shall I ever be asked to come out on strike to support wiremen who may be asking for a rise in wages?

Puzzled Engineer.

The Status of Draughtsmen.

Among the mass of correspondence dealing with industrial questions, the claims of draughtsmen have not received that attention which is undoubtedly their due. Possibly this is owing to the draughtsman's unfortunate habit of brooding over his grievances, rather than openly ventilating them; and it is this peculiarity which has unquestionably led to the passive acceptance of his present relatively low status.

Now, it is quite obvious to everyone that the successful prosecution of the war depends upon the speedy turning out of ships, aircraft, guns, together with a variety of electrical and mechanical devices; but what perhaps is not so generally recognised is the fact that without the draughtsman's skill and ingenuity none of these things could possibly materialise.

In other words, the draughtsman's work is the keystone to the whole of the shipbuilding, engineering, and electrical industries.

The patriotic example shown by draughtsmen in consistently sticking to their work during the national upheaval, when other trades have so easily obtained their objects by other and more drastic methods, has met with little response on the part of the powers that be; but this is only in keeping with the attitude hitherto adopted by those in authority of deliberately refusing to recognise openly the draughtsman's true importance in the industrial world.

As, therefore, it is obviously futile to place reliance in human sympathy and sense of fairness, draughtsmen must look to themselves, and by combined and concerted effort see that the causes which have created this feeling of suspicion and unrest are finally and positively removed.

Might I point out to your readers that the Draughtsmen's Association has already done magnificent pioneer work in this direction, and only the loyal support of all draughtsmen is needed to enable its aims to be successfully achieved.

J. D. Murray,
President, Merseyside Branch of the Association of Engineering and Shipbuilding Draughtsmen.

Birkenhead, *November 30th*, 1917.

[We are fully aware of the high value of draughtsmen's work, and of the low esteem in which, for some inexplicable reason, it is held by the engineering world outside their ranks; and we cordially sympathise with them.—EDS. ELEC. REV.]

Concert.—The Association of Engineering and Shipbuilding Draughtsmen (London Branch) are holding their first Bohemian Concert to-morrow (Saturday) at 7 p.m. at the "Caledonian Salon," Holborn Restaurant. The following are the artists:—Miss Diana Hughes, soprano; Mrs. E. M Pearson, mezzo soprano; Miss Winifred G. Winter, songs at the piano; Mr E. H. Walker, tenor; Mr. Reginald Yates, baritone; Mr. W. Hanson Crossland, tenor; Mr. Fred. Emerton, entertainer; Mr. Albert L. Walter, solo pianoforte; Mr. F. Ollerenshaw, tenor.

WAR ITEMS.

Building Work to be Further Restricted.—At present no building work costing more than £500 may be proceeded with without special permission from the Government. The *Times* states that the regulation is to be carried further. The new Rule will prohibit "any form of constructional or decorative work, with few exceptions, without express permission." The object is to prevent unnecessary work being undertaken while there is a pressing need for men accustomed to such labour for urgent war purposes.

The Coventry Strike.—The strike of 50,000 workers at Coventry, which ended early in the week, represented, says the *Daily Telegraph*, on an eight-hours day basis, the loss beyond recall of 3,200,000 hours of labour on aeroplane production.

Industrial Reconstruction.—Under the auspices of the Employers' Parliamentary Council a national conference will be held at the Central Hall, Westminster, on Wednesday, December 12th, to discuss and determine a united policy in regard to the proposals of the Government with respect to reconstruction and to industry and trade after the war. A resolution will be submitted welcoming the recommendations of the Whitley report, but submitting that to successfully give effect to the proposals it would be essential that agreements between organisations of employers and employed should be legally enforceable; that all combinations of Capital and Labour should be subject to the ordinary law of the land; and that the provisions of the Trade Disputes Act which gave immunity in this respect should be repealed.

A Government Labour Committee.—The War Cabinet has appointed a Government Labour Committee, consisting of the following members:—Rt. Hon. G. N. Barnes, M.P. (Chairman), Sir Auckland Geddes, K.C.B., M.P. (Vice-Chairman), Sir George Askwith, K.C.B., K.C., Mr. Guy Calthrop, Sir Lynden Macassey, K.B.E., Mr. I. H. Mitchell, and Mr. U. Wolff.

The Committee will deal with questions of wages (including the interpretation of the Orders relating to the increase of 12½ per cent. recently granted to plain time-workers in certain industries) and to co-ordinate the settlement of labour questions affecting Government Departments. The committee may confer with a consultative committee consisting of representatives of the principal Government Departments concerned with industrial questions. The functions of the Government Labour Committee will not supersede those of the arbitration tribunals set up under the Munitions of War Acts by the Ministry of Labour.

Exemption Applications.—At Southwark, Messrs. W. P. Catterson & Sons, manufacturers of gas and electric lamps, of Newington Causeway, were requested to show cause why certificates of conditional exemption should not be withdrawn granted to their buyer, 41, in grade 3; a head counterman, 40, fit for labour abroad (B 2); a salesman, 36, in grade 3; and another salesman, 38, fit for sedentary work at home. The firm now employed 15 other men, all over military age, and nine women in the office, who had taken the places of men who had joined up. The bulk of their work was for Government Departments. The counterman had been with the firm 19 years, and was now doing the work of three men. Ald. Hewitt: Will you tell us the number of articles you deal in? Mr. Catterson replied that their catalogue contained over 6,000 articles. Coun. Weaver: It does not appear as if the business would be ruined if we took the counterman. Coun. King: What is to prevent you having a lady in your showroom? Mr. Catterson said that Government contractors called at the showrooms to see if they could obtain substitutes for various articles, and it was essential that there should be a man there with an intimate knowledge of the goods. They had 45 men before the war, but now had only 22. The National Service Representative said the firm was lucky to have three men in low medical categories. These were granted six months' exemption each, and the appeal for the counterman was dismissed, the National Service Representative undertaking not to call him up for three months.

A Glasgow Corporation tramway motorman, 39 years of age, appealed to the Lanarkshire Military Appeal Tribunal against the withdrawal of his exemption. He had been 21 years in the Army, was mobilised on the outbreak of war, and served in Gallipoli and Egypt. He appealed on the ground that he was in a certified occupation. He had been in the Corporation tramways service since 1904. The Sheriff said appellant was in a certified occupation, and exemption was granted.

Rochdale Tribunal put back nine tramway employés, all A, B 1 or C 1 men, to February 28th. Mr. G. Webster, the tramways manager, said there was a shortage of drivers, and the employés had often to work seven days a week and very long hours. Four cars had to be taken off the service in order that the men could appear before the Tribunal.

At the Shoreditch Tribunal, Mr. Lewis Davis, of Curtain Road, E.C., wire coverer of electrical fittings, appealed on business grounds for G. W. Hardy, aged 39 years, classed A, mechanical fitter, for the fourth time. Mr. Davis said it was all electrical work they were engaged on. They made the flexible cord and wiring. There were about 100 girls engaged, and he did not know what would happen if this man had to go. It was highly technical work. His wages were 49s. a week. He felt convinced that many of the girls would be thrown out of work if he had to go. The Tribunal discussed the small wages paid to the man. Hardy said there were about 200 machines running, and he looked after the motors. The Tribunal decided to grant four months, and the Town Clerk said it was the opinion of the Tribunal that this man could not be claimed as indispensable when he was paid so little.

At Windsor, Mr. H. Fowler, electrician, appealed for F. G. Isgrove (18, B 1), his apprentice. Mr. Fowler is in the R.N.A.S., and Mrs. Fowler stated that if Isgrove was taken there would be no skilled person to carry on the business. There was another apprentice, aged 16; both worked together, but the younger lad could not manage the work alone. Five, including her husband, had enlisted from the business, which was the only one of its kind in Windsor. A month's respite was granted to see if anyone could be obtained to replace Isgrove.

At Stratford-on-Avon, there was a Military review of the case of A. Baldwin (40, B 1), electrician to Mr. J. Fielden, Little Kineton. The Military were willing that the man should remain until a capable substitute was found, and Mr. Fielden stated that the man was in charge of his electric light plant, which provided light for the hospital. The Military suggestion was agreed to.

Elland Tribunal has refused an appeal by J. Sykes, electrician, but he is not to be called before the end of January.

Surrey Appeal Court has granted three months' exemption to E. Lown (31), who is in charge of the electric plant at the Farncombe Paper Mills.

East Kent Appeal Court has granted exemption until May 26th to Mr. C. Campbell (41), managing secretary to the Whitstable Electric Co., Ltd.

At Southend-on-Sea, exemption until February 1st was granted to C. C. McBride (18), electrician's apprentice, of Westcliff, to enable him to obtain a commission. He had already been in the Army.

Leyton Tribunal has granted six months' exemption to W. H. Ruddock (31, C 3), electrical mechanic at the Alliance Kinema.

At Southwark, the National Service Representative drew attention to the cases of men granted certificates under the Protected Trades Schedule, pointing out that these men, many of them young and passed for general service or garrison duty abroad or at home, were not called upon when granted their certificates to join the V.T.C. or the Special Police. There was a feeling in the borough, as well as throughout London, by men granted exemption by tribunals who were compelled to join these forces as a condition of their exemption, that the men in munition works should also be compelled to do something of national importance. He thought that these men in munition works were capable of becoming efficient members of the defensive forces. The Tribunal decided to communicate with the department responsible for granting the certificates, urging that it should be a condition that the men securing them should join either the V.T.C., the Special Police, or the Red Cross.

LEGAL.

Gas Light and Coke Co. *v.* Hackney Borough Council.

In the Court of Appeal, before Lords Justices Swinfen Eady, Warrington, and Scrutton, on Thursday, November 29th, the case of the Attorney-General, at the relation of the Gas Light and Coke Co., Ltd., *v.* the Metropolitan Borough of Hackney was heard, upon the appeal of the Gas Light and Coke Co. from the judgment of Mr. Justice Astbury in the Chancery Division.

Mr. Colefax, K.C., in support of the appeal, said Mr. Justice Astbury had dismissed the action with costs, and shortly stated the point had reference to the charges for electricity that were made by the Borough of Hackney—whether or not in their charge for power they infringed the provisions of Sections 19 and 20 of the Electric Lighting Act. The plaintiffs' submission was that Mr. Justice Astbury had not given effect to the judgment of the Court of Appeal in the Long Eaton case, and, further, that he had unduly made distinctions between that case and the present one. In the Long Eaton case the facts were that persons using power for running their machines, if they took all their light from the company, got it at a cheaper rate, while, on the other hand, if they only took it for one purpose, they did not get it at the cheaper rate. The Borough of Hackney had given to the power user a reduced charge in respect of lighting up to the extent of 20 per cent. of the energy user's other charge, thereby giving the user a benefit over one who only took electrical energy for light. The charges were divided under two heads—one for light and one for power, with alternatives for lighting; and the circular of which his clients complained in the present proceedings went on to say that consumers paying under this scale (that was for power) were allowed to use 20 per cent. of the energy supplied, for lighting. Plaintiffs admitted that a power user in respect of electrical energy for power had a better load factor and a better diversity factor than a light user under ordinary circumstances; but the power user when he used

light worsened the position at the central power station, and in fact, *quâ* the user of light, he was no better for the power station—if so good—than the ordinary user of light and the non-power user of light. His broad point was that the Borough of Hackney, having regard to the Long Eaton case, was not entitled to give to a power user a preferential charge in respect of light. It was an inducement to the power user to cheapen the cost of his power by taking light without any corresponding benefit to the station. In the Court below, evidence was given that the charges of the Borough Council of Hackney for power resulted in a loss; but as the learned Judge was of opinion that the evidence was irrelevant, he would not go into that part of the case. He contended that the present case was on all fours with the Long Eaton case.

On Friday Mr. Walter, on behalf of the respondents, in support of the judgment of the Court below, said the appellants' case was based on a misconception as to the true effect of Secs. 19 and 20 of the Act. What they had sought to do was to read the Act as though the sections were not framed to prevent different charges to different consumers but between a different consumption. Electric supply undertakings supplied one thing, and that was electricity. The only interest they had was in the use of the energy supply, in so far as that use affected their cost of supply. An electric light undertaking had to be on a scale to meet the maximum demand which at any time might be imposed on the plant. That was of fundamental importance in considering the question of cost. Capital charges went on whether they generated little or much electricity. The ordinary lighting was only for about two hours a day, taking the year through. Therefore all electric light undertakings endeavoured, as far as they could, to extend the useful work of their station. What the Court was asked to say was that the customer who used the plant for but two of the 24 hours could not be charged differently to the man who used the plant for 11 hours. That was really what the appellants were asking. All the authorities were absolutely in favour of the respondents. If they had to make separate charges to consumers who used both power and light, they would have to have separate meters and separate wiring, which would probably cost thousands of pounds. The Act of Parliament had nothing to do with power, nothing to do with light, and nothing to do with charges. They had power to distinguish between the classes of consumption and the classes of consumers. There was no such distinction known as a differentiation between power and light for the purposes of the Act. No evidence had been given at the trial that there was any undue preference. The prices were based on the fact that if they got a customer of a certain kind the prices charged by the station would be remunerative. There was no suggestion in the evidence that the rates were not perfectly fair. The only thing that was suggested was that the respondents were not entitled to charge the consumers on that basis.

The further hearing was adjourned until Monday.

Re Taylor & Co. (Hatton Garden), Ltd.

In the Chancery Division, on Friday, Mr. Justice Astbury granted an injunction restraining Taylor & Co. (Hatton Garden), Ltd., and Miss Julia Taylor and Ernest W. Tester, the signatories and shareholders of the company, from using the name Taylor & Co. (Hatton Garden), Ltd.

Mr. F. Russell, K.C., who appeared for the plaintiff, Moritz Bergl, an Associate Member of the Institution of Electrical Engineers, said he had a considerable experience in the mica trade, and in 1912 he came in touch with the defendant, Miss Taylor, who was the sole owner of the business in Hatton Garden of Taylor and Co. They entered into a partnership, which eventually was dissolved, and the partnership assets were to be sold. In the meantime, the defendants had registered the name of the defendant company, and the plaintiff only discovered this from an announcement in the Electrical Review. He (counsel) submitted that no one knowing that a company with this name had been formed would bid at the sale for the partnership goodwill, and the sale would be prejudiced by the name being allowed to remain on the register.

Mr. Ram, for the defendants, said Miss Taylor had not intended to do anything wrong; she hoped that no one from the outside would attend the sale, and that she would secure the business. She intended to do nothing with the company until the sale was completed.

His Lordship said the case for the defendants was hopeless, although he was not satisfied that the lady intended to do wrong. The injunction must go with costs. Both parties then agreed to the appointment of a Receiver of the partnership business.

Tramcar Fatality Claim.

At Leeds Assizes, last week, Miranda Dickinson, widow of a Huddersfield Corporation tramcar driver, claimed £500 damages against the Great Northern Railway Co. in respect of the death of her husband, Lewis Dickinson, who died as the result of injuries received in a collision between his car and a railway lorry. There was conflicting evidence as to the lorry's lights. The jury found for the plaintiff, the lorry having crossed the tramlines either diagonally or broadside on, and the lights being, therefore, not fully effective. The parties being agreed as to £500 damages, the jury were asked to apportion the amount, and awarded £250 to the widow, £100 to a boy child aged 12, and £150 to an infant child.

Goodland *v.* Edison Accumulators, Ltd.

In the King's Bench Division, on Monday, Mr. and Mrs. Goodland, of Maida Vale, were awarded £695 damages against the Edison Accumulators, Ltd. The female plaintiff received serious injuries, alleged to have been due to the negligent driving of a motor lorry by the defendants' servant on April 30th. The lorry, it was stated, turned on to the footpath, knocked over a motor-cycle and side-car, and then knocked down Mrs. Goodland.

Mr. Thorn Drury, K.C., for the defendants, admitted that Mrs. Goodland met with a nasty accident, but said she had made an extraordinarily good recovery. The only question was the amount of the damages.

Mr. Rigby Swift, K.C., for the plaintiffs, asked the jury to give compensation to the husband for the medical and other expenses he had been put to, and, far more important, to give compensation to Mrs. Goodland for the pain and suffering she had undergone in consequence of the accident.

Medical evidence was called on both sides, and Mr. Justice Coleridge having summed up, the jury awarded £95 to the husband and £600 to the wife, and judgment was entered accordingly.

Mr. Drury considered the damages excessive.

His Lordship: Then you must go to the Court of Appeal.

Hendon Electric Supply Co. *v.* Banks.

Justices A. T. Lawrence and Shearman, sitting as a Divisional Court, heard the appeal of the Hendon Electric Supply Co. from a decision of the County Court Judge at Barnet in the action of the company against Walter Banks, of the Hampstead Garden Suburb.

Sir E. Pollock, K.C., M.P., and Mr. Ball were for appellants, and Mr. Emery for respondent.

Sir E. Pollock stated that appellants brought an action in the County Court to recover a sum of £3 6s. 5d. in respect of electricity supplied to the defendant. The County Court Judge held that the plaintiffs were not entitled to recover, holding that the Electric Lighting Order applying to this case laid it down that the ascertainment of the amount was first to be made by an electric inspector within the meaning of the Act, and that, as that had not been done, the plaintiffs were disentitled to proceed with their claim. He, therefore, gave judgment for the defendant. The matter was of importance to the appellants, and, therefore, an appeal had been allowed by the County Court Judge. If the latter's decision stood, it fettered to a large extent the powers of the company to recover against the consumers of their electricity. In June of last year a new meter was fixed upon defendant's premises. When the meter was fixed, they forgot to take out the locking screw, the result of which was that the meter did not register. At the end of the quarter in September not much remark was made of the fact that no electricity was registered as having been consumed; but when the December quarter came, and no electricity was registered as having been consumed, the company were surprised, and on February 22nd they sent an inspector, who found that the meter was not working, and he pulled out the locking screw. Then the question arose as to how to ascertain the amount of electricity which had been consumed. The company claimed in accordance with the Act and the contract on the basis of the consumption in the corresponding quarter in the previous year.

Mr. Emery, for respondent, said there were several meters in the house, and the one in question controlled a heating apparatus which, defendant said, was not used during the periods in question, for he was using coal fires for heating.

Sir E. Pollock said a letter had been written since the trial at Barnet, in which it was agreed that the County Court Judge held that electricity had been used through this meter in the periods in question.

Mr. Emery dissented from that, and said the County Court Judge made no finding of fact at the trial. Upon the question of law he gave judgment for the defendant, without costs.

Justice Shearman: It is a point of law we are here to decide, is it not?

Sir E. Pollock: Yes. The defendant by contract in writing dated March 20th, 1915, agreed to take a supply of electricity upon certain conditions, under which defendant agreed to the supply being ascertained by the meters provided by the company; and, in the event of any difference as to the correctness of the meter, the dispute was to be settled in the manner provided by the Electric Lighting Acts. One of the clauses of these Acts provided for the appointment of an inspector to ascertain the amount of electricity which would have been consumed if the meter had been working, but no inspector had been appointed in this district for that purpose.

Justice Shearman: If an inspector were appointed, you would have to pay his salary, and that would probably be larger than the amount you would receive under his awards.

Sir E. Pollock pointed out that if an inspector were appointed, the consumer would have to pay the costs if he had acted unreasonably in raising a dispute before him. And in the ordinary case the inspector would have no power to give judgment; all he could say was whether the meter was right, and then the company would have to sue the consumer in the County Court.

After hearing Sir E. Pollock argue the legal point in the case, their Lordships gave judgment without calling upon Mr. Emery for respondent.

Justice Lawrence, in his judgment, said that Clause 57 in the Schedule of the Electric Lighting Act of 1899 provided that where a difference arose between the consumer and the undertakers as

to whether any meter was not in proper order for correctly registering the value of the supply, that difference should be determined, upon the application of either party, by an electric inspector appointed by the local authority or by the Board of Trade, and that inspector should order by which of the parties the costs in the proceedings before him should be paid, and the decision of the inspector should be final, binding all the parties. A determination by the inspector was demanded by the consumer in this case, and unfortunately no electric inspector had at that time been appointed. He did not see that that entitled the County Court Judge to assess the amount of electricity consumed. He was bound to say, as he did, that the Act of Parliament had itself provided for the mode of determining such a dispute, and until it was so determined, no cause of action arose. He did not see why it could not still be determined, and then a cause of action would arise; but that point had not been argued, and therefore he did not judicially decide it.

JUSTICE SHEARMAN: I am of the same opinion, for the same reason.

The appeal, therefore, was dismissed, with costs.

BUSINESS NOTES.

The Tungsten Lamp Association.—An announcement issued by the secretary, Mr. A. Lazenby, states that as from December 1st this association has removed its offices to 46, Queen Victoria Street, London, E.C. 4. The telegraphic address and telephone number are unaltered.

Ferranti Contracts.—MESSRS. FERRANTI, LTD., have received the following contracts:—

Manchester Corporation.—Annual contracts for meters and for current transformers, also a contract for three 500-K.V.A. three-phase transformers.
Kilmarnock Corporation.—One 100-K.V.A. three-phase transformer.
Birmingham Corporation.—One 100-K.V.A. three-phase transformer.
Darlington Corporation.—One 400-K.V.A. three-phase transformer.
Hal Williams & Co. (for Clayton & Shuttleworth, Ltd.).—One 375-K.V.A. three-phase transformer.

German Company for Ship Installations.—The Schiffs Installation Akt. Gesell. has been founded at Bremen (with a capital of £68,500) with the special object of manufacturing and installing apparatus for the electrical equipment of ships. The founders of the company are:—The Lloyd Dynamo Werke (Bremen), Backethal Draht u. Kabelwerke Akt. Ges. (Hanover), C. Lorenz Akt. Ges. (Berlin), Deutsche Nationalbank (Bremen), and Kommerz u. Disconto Bank (Berlin).

Dissolution.—ELECTRICAL MEDICAL MANUFACTURING CO., 161, Gower Street, London.—Messrs. A. Lloyd & R. J. Wickham have dissolved partnership. Mr. Lloyd will attend to debts and continue the business.

Book Notices.—The November issue of the Tramways and Light Railways Association *Journal* contains the full report, by Col. Pringle, of the Board of Trade, on the Dover tramway accident.

"Practical Electricity." By T. Croft. London: Hill Publishing Co. 8s. 4d. net.

Catalogues.—MESSRS. EDGAR, ALLEN & CO., LTD., of Imperial Steel Works, Sheffield, have issued a brochure entitled "The Making of a Tramway Point." The earlier pages contain many half-tone photographic reproductions illustrating the various stages of manufacture of a tramway point. The latter half of the book contains a reprint of a paper by Mr. F. Bland on "1883 to 1913, or Thirty Years of Tramway Practice."

LIGHTING AND POWER NOTES.

Barrow-in-Furness.—PRICE INCREASE.—In view of the increasing cost of coal, the T.C. has agreed to a general increase of 20 per cent. in the flat rate and demand system charges. Prepayment meters:—Flat rate, 20 to 25 per cent. increase; on the demand system the fixed weekly charges will be increased by 2d. to 3d. per week. The tender of Messrs. Siemens for sub-station switchgear, at £403, was approved, as also a proposal of the electrical engineer to ask for Government authority to order an additional turbo-alternator, and obtain tenders for same.

Blackburn.—PRICE INCREASE.—The Electricity Committee has decided to advance the price of electricity by 10 per cent., making 25 per cent. since the war started.

Braintree.—PROV. ORDER.—The Crittall Manufacturing Co., Ltd., has applied for a prov. order for electric supply within the area of the U.D.C.

Calder Valley (Yorkshire).—WAGES BOARD.—It is expected that a municipal wages board for the various towns and townships of the Calder Valley will shortly be established, covering Halifax, Brighouse, Elland, Todmorden, Sowerby Bridge, Hebden Bridge, Luddendenfoot and Mytholmroyd.

Cleckheaton.—A breakdown to the generating plant has necessitated an appeal to the public to restrict the use of electricity during the evening.

Colne.—The Electricity Committee has appointed a Sub-Committee to consider the question of an advance in the price of electric current, in view of the advance in the cost of coal.

Darwen.—WAGES.—The Corporation has declined an application for an advance of £1 per week in the wages of employés at the electricity works, put forward by the Union of Enginemen.

Deal and Walmer.—PROV. ORDER.—The B. of T. has prolonged the prov. order of the electricity company for a year.

Derby.—EXTENSIONS.—An important scheme for the development of the electricity undertaking, involving a total outlay of over £50,000, has now been decided upon. This includes the erection of a coal elevator, for which the tender of Messrs. G. Fletcher & Co., at £880, has been accepted; additions to the three-phase distributing mains, at a cost of £9,000, and additional plant at the power station costing £40,500. The latter is made up as follows:—Two new boilers, economisers, extension of elevator, and new chimney, £15,000; one 4,000-KW. turbo-alternator, £24,000; piping and brickwork for two boilers, turbine bed, and switchgear, £1,500. Also an electric jib crane is to be purchased from Messrs. E. Morley & Sons, at £350.

Dewsbury.—RESTRICTED LIGHTING.—The outcome of the elaborate scheme for controlling lighting, proposed by the Chamber of Trade, has been an intimation from the Home Secretary that, after careful consideration of the scheme, he has decided that he cannot amend the existing order.

Dukinfield.—FIRE.—Last week a fire occurred at the sub-station of the Joint Tramways and Electricity Board; the damage is estimated at about £200, and is covered by insurance. In order to effect repairs, the current had to be cut off, and was not fully restored until next day, with a serious result upon electrically-driven mills and business premises in Dukinfield and Hyde, whilst tramway traffic between Alma Bridge and Hyde was stopped for a time.

Fort William.—At a meeting of ratepayers it was agreed to petition against the water-power scheme of the British Aluminium Co., Kinlochleven.

Guiseley.—PROV. ORDER.—The Electrical Distribution of Yorkshire, Ltd., has given notice of its intention to apply for a prov. order to supply electricity within the townships of Guiseley and Menston. At the request of the D.C.'s concerned, a clause is to be inserted giving the local authorities the option of purchasing the undertaking at the end of a given period.

Hebden Bridge.—PRICE INCREASE.—The U.D.C. has decided in Committee to advance the electric lighting charges by 8½ per cent., and power charges by 20 per cent., from January 1st.

High Wycombe.—STREET LIGHTING.—The T.C. has agreed to enter into a new contract for public lighting with the local electricity company for seven years as from January 1st, 1916, the date of the existing dispute, subject to the company accepting £400 for the standing charge payment for 1916 instead of £600, as demanded. If this is accepted by the company, the present action now pending in the Courts will be stayed, each party paying its own costs. The terms of the contract are:—Fixed standing charge, £400 a year; 13 300-watt lamps, £4 each; 110 100-watt lamps (all night), £2 10s. each; 62 100-watt lamps (half night) £1 10s each.

Hull.—PRICE INCREASE.—The Electricity Committee has decided to increase electricity charges on January 1st by ½d. per unit on the flat rate, making 18¾ per cent. increase on pre-war rates, and by a further increase of 17½ per cent. on all other units, making 32½ per cent. on pre-war rates.

Keighley.—The Electricity Committee has prepared for submission to the Council a report on the question of increasing the capacity of the boiler-house plant at the generating station, and recommends a fan installation, at an estimated cost of £1,500.

Leeds.—RESTRICTED LIGHTING.—The Chamber of Trade's efforts—supported by all the shopkeepers' organisations of the West Riding—to persuade the Home Office to fix definite times, covering a period of a fortnight or a month, for reduced shop lighting during the winter, instead of the daily movable times governed by the sunset, has ended in a decision of the Home Office that, after consultation with the military authorities, it cannot sanction any alteration of the present system.

Leicester.—PLANT EXTENSION.—The T.C. has decided to apply to the B. of T. for a prov. order authorising the acquisition of land and the construction of a new generating station. The initial instalment of the scheme comprises machinery of 6,000-KW. capacity, and this, together with buildings and land, will involve an expenditure in the aggregate of £285,000, made up as follows:—Water-tube boiler plant, £36,000; turbines, £18,000; alternators and switchgear, £10,500; surface condensers, £7,500; water piping, circulating pumps, screens, &c., £10,500; buildings, coal and ash handling plant, and foundations, £54,000; contingencies, £13,500; other constructional works and land, £135,000. Alderman Flint, the chairman of the Tramways and Electricity Committee, said this was only an approximate estimate of the cost

of the first instalment of the scheme for the purposes of the Board of Trade, and would be subject to revision when a detailed scheme was brought before the Council for adoption. It was estimated, however, that the undertaking would not cost the ratepayers anything.

London.—The South London Electricity Supply Corporation has decided to increase the charges for power by 11 per cent.

Lancaster.—Price Increase.—It has been decided to increase the price of electricity by 25 per cent.; the increase takes effect in January.

Nottingham.—Wages.—The Committee on Production has given its award on the recent arbitration with regard to the wages demand of Corporation (gas, tramways, electricity, health, &c.) employés, by the National Union of General Workers and the National Union of Tramway and Vehicle Workers. The advances granted by the award represent about £20,000 a year.

Southport.—Price Increase.—The Finance Committee of the T.C. recommends an increase of 5 per cent. in the charge for electricity.

Stoke-on-Trent.—Price Increase.—At the last meeting of the B.C. a recommendation of the Electricity Committee was approved in favour of a further advance of 6¾ per cent., making 40 per cent. in all, upon all supply and other charges payable to the Electricity Supply Department, to be charged upon the gross total of each account from and after the next meter readings in December. Ald. Leese, the chairman, pointed out that the increased price would just save the Committee from a loss if there were no further increase next year in the cost of production. They were now paying £11,000 a year more for coal and £3,000 in war bonuses to workmen.

Sunderland.—The Electricity Committee has refused a request of the County of Durham E.P. Distribution Co. for consent to the latter supplying energy to the Egis shipyard at Pallion (in the Corporation area of supply). The Committee decided not to entertain a proposal for interchange of energy between the Corporation and Newcastle-on-Tyne Electric Supply Co. It was further announced, in view of statements to the contrary, that the Corporation undertaking was satisfactorily meeting all demands, and was prepared to negotiate for the supply of additional energy if required.

West Ham.—Price Increase.—The Electricity Committee recommends the following prices for electricity:—Lighting, 6d. per unit; factory, 3d.; maximum demand rate cancelled. Household tariff, £10 and 1d. per unit. Power and heat, 1½d. per unit. Heating (domestic), 10s. to 6s. 8d. and 1d. per unit. Arc lamps, 3½d.—3d. per unit. Discounts over £15, 2½ per cent.; over £45, 5 per cent. Minimum charge for service, £1 per annum, or special charge if necessary.

TRAMWAY AND RAILWAY NOTES.

Accrington.—Pending a final settlement on the matter, it has been decided by the Electricity and Tramways Committee to charge the Haslingden Corporation 5d. per car-mile during the present year for the tramway service provided to the latter authority.

Grimsby.—Steps are being taken to improve the tramway service, the tramway manager having attended a meeting of the Committee, and made certain proposals with this end in view. The Committee has also considered the expiration of the Council's agreement with the company in 1921, and a Sub-Committee was to be appointed to deal with this matter.

Halifax.—Railless Traction.—The Tramways Committee proposes to purchase two railless cars from the Dundee Corporation, at a cost of £625 each.

The Tramways Committee has agreed to the request of the Amalgamated Association of Tramway and Vehicle Workers that Christmas Day be an entire holiday for the whole staff.

Hull.—A report on the question of repairs and renewals of the electrical power plant, presented to the Tramways Committee, states that unless considerable risk is incurred by the Committee, the provision of additional power should not be long delayed. A spare armature ought to be purchased at a cost of £1,310, but sanction had been refused. The provision of a third generating set, which was a preferable course, would involve an expenditure of between £10,000 and £15,000. The report is to be fully considered at a special meeting of the Tramways Committee, when also the question of obtaining power from the electricity department will be debated.

Keighley.—Increased Fares.—The Tramways Committee recommends an increase in fares on trolley vehicles, to take effect from December 8th.

Lancashire.—Christmas Day Services.—The Rochdale Corporation tramway employés have decided to refuse to work on Christmas Day; their application for a holiday on that day had been previously declined by the Tramways Committee. The men's decision is subject to confirmation by the Lancashire District Council of their Association. The men were informed at their meeting that a score of undertakings were closing down for a day's holiday this Christmas. Colne T.C. has declined to grant the request for a holiday, as also have Bolton and Burnley. In the last-named town the Christmas Day passengers during the past five years have averaged about 50,000.

The Oldham T.C. has decided to suspend its service on Christmas Day; the Salford tramway employés have decided by vote not to work on that day.

Newcastle-upon-Tyne.—The Corporation Tramways Committee has agreed to grant the men's request, and close the service down on Christmas Day.

Wigan.—Owing to the recent flooding of the River Douglas, the Wallgate depôt was inundated, and the services of the fire brigade were requisitioned to pump out the water.

TELEGRAPH AND TELEPHONE NOTES.

France and the United States.—A wireless station is to be erected shortly by the Government on the west coast of France, to carry on continuous communication by day and night with the United States. It will emit continuous waves of at least 15,000 m. wave-length, and will be guaranteed to transmit 10,000 useful words per day on any day in the year. It will also be able to transmit and receive continuously at the minimum speed 4,000 words an hour, transmission and reception being carried on simultaneously and independently.—*Annales des Postes, Télégraphes, et Téléphones.*

South America.—The Central and South American Telegraph Co. has received a message from its agent at Rio de Janeiro, to the effect that the Brazilian Government has finally signed the contract for the extension of its all-American cables *via* Colon to Brazil, by cable from Buenos Ayres to Santos, and another cable from Buenos Ayres to Rio de Janeiro. These extensions will be carried out as soon as war conditions will permit.—*T. and T. Age.*

Telephonic Relays.—In *Annales des Postes, Télégraphes et Téléphones* an account is given of recent tests of telephonic relays between Paris and Marseilles, over a circuit of 3·5-mm. copper wire. The apparatus—a vacuum amplifier—was installed in the office at Lyons, and its use brought up the speaking efficiency of the circuit to equality with that of the two other Paris-Marseilles circuits, which consist of 5-mm. copper wire. The copper in the former weighs about half as much as in each of the latter circuits, and the difference (150 tons), at £160 a ton, would be worth £24,000.—*Journal Télégraphique.*

Wireless Schools.—Two thousand wireless operators are needed by the Government, and the Marconi Co. is arranging with the Portsmouth Education Authority to open classes.—*Daily Chronicle.*

CONTRACTS OPEN AND CLOSED.

OPEN.

Argentina.—February 23rd, 1918. Rosario Municipality. Establishment of telephone service within the municipal radius. Conditions on application.

Bolton.—January 15th. Electricity Committee. One 7,500-kw. turbo-alternator with condensing plant. See "Official Notices" to-day.

Great and Little Usworth.—Work in connection with electric lamps belonging to the Parish Council. Mr. J. Elliott, clerk to the Council, Fern House, New Washington, Co. Durham

Manchester.—December 12th. Three fan draught cooling towers at the Stuart Street station, for the Electricity Committee. See "Official Notices," November 16th.

CLOSED.

Derby.—T.C. Coal elevator for the electricity works: P. Fletcher & Co., £880. Electric jib crane: E. Morley & Sons, £350. Electric omnibus and chassis: Edison Accumulators, Ltd., £1,023.

Faversham.—T.C. About 300 tons of coal for the electricity works: Francis Davis, 44s. per cwt.

London.—Stepney.—Electricity Committee. Accepted tenders: Messrs. E. Foster & Co., 2,000 tons West Cannock nutty slack, at 22s. 10d. a ton; 3,000 tons Ibstock D.S. nuts, 23s. 2d. a ton; 5,200 tons Walsall Wood Beans, 24s. 1d. a ton; 3,000 tons Hawkin's Cannock nutty slack, at 23s. 4d. a ton.

Salford.—The E.C. recommends the acceptance of the tender of Messrs. W. T. Glover & Co., Ltd., for paper-insulated lead-covered cable, required in connection with the supply of electricity to the premises of Messrs. P. R. Jackson & Co., Ltd., in Hampson Street, Salford, for £570.

Sutton.—U.D.C. Ten-line intercommunication telephone instruments: Messrs. Stuart & Moore, Ltd., £67.

Weymouth.—The T.C. has agreed to sell to Messrs. Banks, Warner & Co., a 150-KW. Diesel engine, at the electricity works, for £1,300, and to purchase from Loughborough a 350-KW. steam set for £950. This is on account of the prohibitive price of fuel oil.

FORTHCOMING EVENTS.

Junior Institution of Engineers.—Friday, December 7th. At 8 p.m. At 39, Victoria Street, S.W. Paper on "Maintenance of Engineering Plant," by Mr. J. G. Moon.

Chief Technical Assistants' Association.—Saturday, December 8th. At 3 o'clock. At the Tavistock Hotel. Paper on "Motor Converters *v.* Motor Generators," by Mr. Baron.

North of England Institute of Mining and Mechanical Engineers.—Saturday, December 8th. At 2 o'clock. At the Wood Memorial Hall, Newcastle-on-Tyne. General meeting.

Birmingham and District Electric Club.—Saturday, December 8th. At 7 p.m. At the Swan Hotel, New Street. Annual meeting.

Association of Engineering and Shipbuilding Draughtsmen (London Branch).—First Bohemian Concert. Saturday, December 8th. At 7 p.m. At the Caledonian Salon, Holborn Restaurant.

Royal Society of Arts.—John Street, Adelphi, W.C. Monday, December 10th. At 4.30 p.m. Cantor Lecture, "Progress in the Metallurgy of Copper," (Lecture II) by Prof. H. C. H. Carpenter, F.R.S.

Wednesday, December 12th. At 4.30 p.m. Paper on "Technical Training for Disabled Soldiers and Sailors," by Lord Charnwood.

Thursday, December 13th. At 4.30 p.m. Paper on "The Trade of India with Russia, France and Italy," by Mr. D. T. Chadwick.

Association of Supervising Electricians.—Tuesday, December 11th. At 7.15 p.m. At St. Bride's Institute, E.C. Paper on "Some Notes on Transformers," by Mr. A. J. Cridge.

Faraday Society.—Wednesday, December 12th. At Burlington House, Piccadilly, W. At 7.30 p.m. Annual general meeting.

Association of Engineers-in-Charge.—Wednesday, December 12th. At 8 p.m. At St. Bride's Institute, E.C. Paper on "Some Phases of Modern Industrialism," by Mr. A. W. Wyatt.

Institution of Electrical Engineers.—Thursday, December 13th. At 6 p.m. At the Institution of Civil Engineers, Great George Street, S.W. Discussion on "The Metric System," with introductory papers by Mr. L. B. Atkinson and Mr. A. J. Stubbs.

(Manchester Local Section).—Tuesday, December 11th. At 7 p.m. At the Engineers' Club. Paper on "Electrical Cooking as applied to Large Kitchens," by Mr. W. A. Gillott.

(Scottish Local Section).—Tuesday, December 11th. At 7.30 p.m. At 207, Bath Street, Glasgow. Paper on "Gas Firing Boilers," by Mr. T. M. Hunter.

(Students Section).—Tuesday, December 11th. At King's College, Strand, W.C. At 7 p.m. Discussion on "Recent Applications of Electricity."

Institution of Mechanical Engineers.—Friday, December 14th. At 6 p.m. At the Institution of Civil Engineers, Great George Street, S.W. Paper on "The Use of Soap Films in Solving Torsion Problems," by Mr. A. A. Griffith and Mr. G. I. Taylor.

Electro-Harmonic Society.—Friday, December 14th. At 8 p.m. At the Holborn Restaurant (Venetian Chamber). Smoking Concert.

Greenock Electrical Society.—Saturday, December 15th. Visit to Glasgow Central Station.

Association of Mining Electrical Engineers (West of Scotland Branch).—Saturday, December 15th. At 3 p.m. Visit to Messrs. Mavor and Coulson's Works, Glasgow. Concert at Trades House Restaurant, 89, Glassford Street.

Society of Engineers.—Monday, December 17th. At 5 p.m. At the rooms of the Geological Society, Burlington House, Piccadilly, W. Lecture by Mr. Chalmers Kearney on "High-speed Railways after the War" (postponed from December 3rd).

NOTES.

The Filiform Crystal and its Use in the Glow Lamp.—Before a recent meeting of the German Illuminating Engineering Society, reported in the *E.T.Z.*, of October 28th, 1917, F. Schröter gave some particulars of the process adopted by Julius Pintsch & Co., for producing a continuous tungsten crystal which is used in place of the ordinary drawn wire for glow lamps. As is well known to investigators, metals when worked mechanically undergo certain structural alterations, the crystal grains forming the structure being displaced in certain directions. The change is accelerated by the application of heat. The return to the stable condition, when the normal crystalline structure again predominates, is known as recrystallisation.

In the case of the glow lamp we have a typical example of the "fatigue" of a metal with high temperature. A drawn tungsten wire, which in the initial cold state has a structure made up of parallel fibres and therefore possesses great elasticity, shows, when submitted to a microscopical examination after burning at a temperature of 2,300° C., the reformation of the irregularly distributed individual crystals. At the temperature of the half-watt lamp, viz., 2,700° C., recrystallisation is visible after a few minutes. When recrystallisation is complete the most valuable properties (extensibility and flexibility) which the drawing process has imparted to the tungsten wire, disappear.

The object of the new Pintsch process is to obtain glow lamps which shall have anti-vibration filaments both in the cold and hot state. Filaments were first produced by the squirted (*not* drawn) process, with the addition of about 2 per cent. of thorium oxide. In certain places on the filament the wires were much more flexible than pure tungsten wire; but at irregular intervals they were brittle even when errors of manufacture were avoided. The first deciding factor in the modified process was the fact that individual crystals occur red, these crystals going to make up the filament. The problem has been solved by taking a wire, containing thorium oxide, and obtained by the squirted process, and heating as short a length as possible at 2,400° C., quickly raising this temperature to 2,600° C., and moving the wire through the heating apparatus at a velocity somewhat lower than the velocity of propagation of the crystallisation process.

Fresh sections of the wire are continually being exposed to the high temperature region, and the process is continued until the entire length of the filament is overgrown by the crystal. This "forming" process is carried out in a hydrogen atmosphere owing to the tendency of tungsten to oxidise. The wire, as it leaves the forming apparatus, is incorporated into the lamp without further treatment.

The main feature of the process is that the structure of the tungsten filament is that of one continuous crystal instead of being composed of a number of single crystals unequally distributed.

Practical tests that have been made show the superiority of the filiform tungsten crystal for the purposes for which it is intended, owing to the stability of its structure at high temperature and its mechanical properties. Its tensile strength, viz., 164 kilogrammes per square millimetre, is higher than that of steel wire, although less than that of drawn tungsten wire. The crystal filament is so malleable that it can be wound round the smallest mandrel, and it maintains this property even after burning for an extended period. Owing to the small percentage of thorium oxide included, the radiant properties of the crystal filament are pretty much the same as those for pure tungsten wire.

A Substitute for the Leclanché Cell.—In a communication in the September—October number of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, Prof. Féry describes a new type of wet primary cell that he has elaborated. The Leclanché cell, depolarised by manganese dioxide (which used to be obtained from Germany) is the most common type at the present day. Prof. Féry conceived the idea of doing without manganese dioxide and depolarising the cell with the oxygen of the air. Hitherto attempts in this direction had not met with much success owing to the zinc electrode being vertical in position, giving rise to certain disadvantages, viz.:—

1. The zinc—easily oxidised—absorbs oxygen as it dissolves, which is liberated on the surface of the liquid, so that the carbon immersed in the deoxidised liquid is polarised when the circuit is closed.

2. The surface action of the aerated liquid on the zinc tends to corrode the electrode where it is immersed in the liquid.

3. The oxy-salts of zinc thus formed in the mass have a tendency to cause "creeping" of the salts.

4. The crystals of oxychloride of zinc and ammonia due to this reaction, attack the zinc and the carbon and decrease the active surface of the electrodes.

5. This continuous action of the oxygen dissolved in the liquid on the zinc electrode causes a local attack which tends to increase out of all proportion to the theoretical consumption.

To overcome these defects, and use the air as the depolariser, the author has given the zinc electrode the form of a horizontal plate placed at the bottom of the cell. The carbon electrode is vertical, being separated from the zinc by a thin sheet of felt or an ebonite cross piece.

Local action in a cell of this type is practically eliminated, and the quantity of zinc dissolved is 1·24 grammes per ampere-hour. The voltage on open circuit is 1·18.

Certain continuous tests have been made on cells of this type and the results are given in a table accompanying the original paper.

In comparative tests carried out by one of the French railway companies on four of the new cells and four Leclanché cells, after eight months of continuous operation on a resistance of 700 ohms, the manganese (Leclanché type) cells had used up two zinc rods each weighing 150 gm., while the new cells had only used one zinc sheet weighing 120 gm. A cell of the new type capable of yielding 90 ampere-hours weighs only 2·1 kg. (about 4·6 lb.). It is possible to obtain this output of 90 ampere-hours with 100 gm. of sal-ammoniac, the concentration of the solution being 12 per cent.

A brief account of this cell, with a drawing, was given in our issue of August 10th, 1917, p. 129.

German Economy in Lubrication.—It is now some time since a German committee appointed to consider the matter issued a report making numerous recommendations with a view to eliminating waste in lubrication. In recognition of the fact that it is seldom possible to get individual workpeople to add to their other duties, a live interest in and effective application of the principles of economy in lubrication, a number of German works now make one person definitely responsible for the sufficient yet economical lubrication of a certain number of machines. It is this person's duty to lubricate the machines once or more in each 24 hours as may be necessary; and he or she is trained to use as little oil as effectively as possible. The "lubricator" has also to collect oily waste and oil collected in drip pans, &c. Each machine operator is given a small emergency supply of oil and is held strictly accountable for this. It is said that these measures resulted in 40 per cent. reduction in the oil consumption of a certain works where it was thought that the consumption had already been reduced to a minimum.

National Service for Small Engineering Works.—A Conference, convened by the Aeronautical Institute, of smaller engineering firms not fully engaged on war work, and capable of undertaking work in connection with aircraft production, took place on November 29th, with Mr. A. J. Liversedge in the chair. The Conference was attended by several hundred representatives from all over the country. The Institute proposes to help the small manufacturer by instituting one or more centres where samples of any parts can be seen in different stages of manufacture; by providing newcomers with full information and technical assistance concerning the making of any parts they may undertake to do; and by putting at their diposal jigs, &c., that have in practice proved successful and accurate. The small manufacturer can produce parts at a low cost only if he be given standing repetition work for two or three parts suitable to his plant and labour; and this repetition work can be obtained only if all the smaller firms interested act together as one big concern, and each individual firm produces in quantities its quota; therefore, one or more centres should be established at which the Government could deliver in bulk, for re-distribution among the members of the proposed body by a Committee of the body itself, and one or more centres should be established to which all finished articles would be sent for inspection in bulk by Government inspectors. A resolution was carried approving of the proposals of the Institute, and appointing a Committee to carry them into effect.

Volunteer Notes.—County of London Volunteer Engineers (Field Companies).—Headquarters, Balderton Street, Oxford Street, W. 1.

Orders for the week, by Lieut.-Colonel C.B. Clay, V.D., commanding:—
Officer for the Week.—Second Lieut. P. Bowden.
Drills.—Week ending Sunday, December 16th, 1917:—
Monday.—No. 3 Company, Left Half. Recruits, signalling, 6.30.
Tuesday.—Physical drill and bayonet training, 7.30.
Wednesday.—No. 1 Company, 6.30.
Thursday.—No. 2 Company, 6; signalling, ambulance, 6.30.
Friday.—No. 3 Company, Right Half. Recruits, 6.30.
Sunday.—Commandant's parade for instruction in camp arrangements at Esher. Parade, Waterloo Station, opposite No. 10 Platform, 8.30 a.m. Uniform.
Musketry.—Belvedere Road, Tuesday, Wednesday, and Thursday, 6 to 8.
Note.—The Medical Officer will attend for examination of recruits, &c., on Thursday, at 6.30.

(By order) Macleod Yearsley, *Capt. and Adjutant.*

Municipal Tramways Association and B. of T. Tramways Committee.—Several municipalities, both north and south of the Tweed, are very much concerned in regard to the powers of the new National Tramways Committee, which has been appointed by the Board of Trade to consider the needs of the various municipal and company tramway undertakings throughout the country, and, if necessary, to close down the less essential concerns. At the meeting of the Executive Council of the Municipal Tramways Association, which was called to consider the question, Mr. Dalrymple, of Glasgow, moved the following amendment, which was seconded by Alderman Flint, of Leicester, who is president of the Association:—"That this Council take no further action on the letter received from the Board of Trade on the question of the expert Committee in respect of materials and labour on tramways, but that the whole question of policy and personnel be referred to a general meeting of the Association to be called forthwith." The motion to proceed with the appointment of the representatives on the National Committee was, however, carried. Steps are being taken to put before the President of the Board of Trade the desirability of having a member on the Committee who will represent the tramway undertakings in Scotland.

The British Fire Prevention Committee.—The British Fire Prevention Committee was formed in 1897, and has now completed the twentieth year of its activities. The Committee's testing station, where the experiments and tests are carried out, and which is such an important part of its work is at North Bank Lodge, Regent's Park. The offices of the Committee are at No. 8, Waterloo Place. Generally speaking, the Committee's work has comprised extensive research work, including many tests; the initiation of questions of legislation, bye-laws, regulations, &c., with the necessary presentation of data and "evidence," and the issue of extensive literature on the subject of fire prevention and extinction, known as the Committee's "Red Books" and "Journals"; the preparation of a number of notices and circulars of a precautionary character, the collection and exchange of technical information and its dissemination from the Committee's inquiry office; the organisation of conferences and technical exhibitions, and, finally, a general propaganda through the Press and elsewhere in the interests of fire prevention.

The most competent authorities in the United States, France, and Russia have been liberal in their praise, whilst authorities in enemy countries, in pre-war days, adopted the Committee's data, and the conclusions drawn from its investigations. In the pre-war period, although the Committee's research work was carried on voluntarily and with limited funds, it was far superior to anything that obtained in Germany or Austria regardless of State aid.

It has not been the ambition of the Committee to court public notice; it has taken as its model the policy of some of the best-managed Government Departments, which is to work unostentatiously for the benefit of the public generally. It has found that by quiet and steady work useful results are more effectively obtained than by the clamour of public meetings and other ostentatious methods. The Government of the day has invariably supported the Committee's endeavours, and every Government Department has rendered the Committee such assistance to achieve its object in the public interest as was in its power.

The Committee has kept largely to facts, and avoided the expression of opinion on subjects of a controversial character, whilst the presentation of facts, as a rule, sufficed to show the reason for the Committee's endeavours.

Lastly, the work within the Committee has been of an harmonious character throughout, and this collaboration has led to the closest friendship between many individual workers. The organisation of the work allows for decentralisation and the allotment of tasks to those specificially conversant with the technical issues involved, and the amount of sustained technical effort and care given by the Committee's workers engaged upon individual problems has been remarkable; in fact, the Committee's reputation for thoroughness and exactitude has been largely based on their generous and painstaking work and voluntary service.

The past 20 years of the Committee's work have demonstrated that, regardless of the opposition of vested and other interests, considerable progress has been achieved, and that the results have been valuable to the citizen and to the State, both from the humanitarian and the economic point of view. We congratulate the Committee on its admirable record of public service, and trust that in the more enlightened future that, we hope, lies before us, its efforts will be still more fully appreciated and effectively aided by the people of this country and their Government.

Graphite in Madagascar.—In an article by Mr. John W. Shelley, of the Madagascar Service des Mines, which appeared in the *Mining Magazine*, some interesting particulars relating to the growing graphite industry in Madagascar were given. The deposits extend for a distance of 400 miles, and so far only the outcrops have been worked. The bulk of the graphite is in the form of thin flakes from ⅛ in. diameter down to fine dust, the amorphous variety being rare; as dug out the ore contains 60 per cent. graphite, but only a third of this is recovered by present methods of dressing. Of this 60 per cent., containing 90-96 per cent. carbon, is suitable for crucibles and furnace linings, while the remainder (fine dust) is used for other purposes. Some deposits contain a large mixture of mica and iron, and await the development of a satisfactory separation process. The deposits are worked by native labour employing their own crude methods of hand washing, &c., and Mr. Shelley suggests that the staff, that is at present producing 25 tons of marketable graphite could with labour-saving devices secure 250 tons. The working cost at the mine averages £9 a ton, and with inland transport, shipping, taxes, &c., added, the total cost amounts to £17—£19 per ton c.i.f. London, under normal conditions.

In 1913 about 120,000 tons of graphite of all kinds represented the world's production. Ceylon produced 40,000 tons and Madagascar 8,000 tons, though the 1915 production of the latter was estimated at 12,000 tons. The graphite exports of Madagascar have risen to the latter figure from 19 tons in 1909. The production is exported to Europe, and used: 60 per cent. for crucible retorts, 15 per cent. for furnace and converter linings, 10 per cent. for paint, 10 per cent. for lubricant, and 5 per cent. for foundry moulding.

Mr. Shelley draws attention to the great possibilities awaiting the development of the graphite industry in Madagascar.

War Taxation on Electrical Energy in Russia.—The Minister of Trade and Industry has drawn up his conclusions on the proposed tax on electrical energy, and states that the project of the Ministry of Finance which has not been hitherto given effect to, comes into prominence again owing to the necessity of seeking new sources of revenue for the Government.

In the opinion of the Minister quoted there ought to be a distinction between the assessment of electrical energy used for lighting and heating, and of that for motive power. That the tax on lighting current should fall entirely on the one obtaining the corresponding advantages is, in his opinion, perfectly fair; but it is quite different with the electric current used for motive power. The encouragement to change over from the more ancient to the more modern methods of production and consumption of motive power is one of the first calls on the economic policy of the Government. The assessment of electrical energy used for as motive power is now quite inadmissible, and can only be applied on condition of the assessment of all kinds of power current generally. In conformity with these considerations the Board of Electrico-Technical Business has prepared a new project of taxation for electrical energy. All electrical current used for lighting and also used for other purposes, if obtained from lighting current mains, unless measured by special meter, is subject to taxation. Electric current used for lighting entertainment establishments, cinematographs, cafés, restaurants, clubs, and all kinds of illuminated advertisements, are to be separated into a special category and subjected to a maximum tariff. Electrical current used for Government establishments, Treasury premises, and concerns for lighting the rolling stock of private railways, and private marine and river ships will not be subject to taxation. The object of the new project is first of all to tax the consumption of electrical energy and not its production. Therefore the tax is to be paid to the Treasury by the owners of electric stations on account of the consumers. The owners of stations in settling their accounts with their subscribers may include the amount of the tax falling on them according to the quantity of useful energy delivered, whilst compensation is permitted also in cases where the payment taken for current along with the amount calculated for the tax, exceeds the selling rate fixed for electrical energy by the local town or county Governments. As the tax on electrical energy is a temporary measure, it will be suppressed when the present serious financial crisis is past. The tax may be at so much per cent. on the selling price of current, or per arc or incandescent lamp.

Institution and Lecture Notes.—Institution of Civil Engineers.—A paper was read, on December 4th, on "Recent Developments in By-Product Coking," by Mr. G. B. Walker. The author described the principal features of half a dozen of the most successful types of oven in use in this country and the recovery plants associated with them, and compared the relative value of the surplus gases used in producing steam (utilised through turbines) and in internal-combustion engines, to the advantage of the latter.

Association of Mining Electrical Engineers.—In the course of his presidential address to the East of Scotland Branch of the Association, Mr. Richard Kirkby, general mining manager of the Wemyss Collieries, stated that the total H.P. of electric plant in use in the coal mines of Great Britain in the year 1913 was 628,097. In 1914 the total H.P. had increased to 713,782, a gain of fully 13½ per cent. Owing to the war the figures for 1915-16 had not been published. In 1914 hauling used 28¾ per cent. of the total plant H.P. of electricity, pumping 27 per cent., and coal-cutting 5½ per cent. He did not favour driving every machine in or about a mine by electricity; there was no doubt that thousands of horses and ponies could be replaced by small electrically-driven rope haulages, and the field for electrically-driven coal cutters was still open for competition by makers who had done very well during the last few years in the way of improving their machines.

Diesel Engine Users' Association.—At the November meeting of the Association, the President (Mr. Geoffrey Porter) reported that the Standing Committee on Insurance Against Breakdown were drafting by-laws to regulate its procedure and to deal with differences that might arise between the underwriters and policy-holders in the interpretation of the Standard Policy, &c. The recent order of the Ministry of Munitions regulating supplies of tar oil for use as fuel in Diesel engines was considered and discussed. Comment was made on the condition in the schedule that acceptance of the producers' weights and measurements in selling tar oil should be compulsory on the purchaser. It was reported that the Controller of the Mineral Oil Production Department of the Ministry of Munitions was arranging for trials of mixtures of pitch and creosote to be carried out, with a view to their adoption for use as fuel for Diesel engines. The hope was expressed by the meeting that actual users of Diesel engines under normal working conditions would be given an opportunity of thoroughly testing any such fuel and reporting thereon, before any final decision was arrived at by the Controller as to its suitability. Mr. George W. F. Horner read some notes on "The Lubrication of Air Compressors." A communication from Mr. J. Veitch Wilson on the subject of "Lubrication of Air Compressors and Diesel Engines" was also read. An interesting discussion followed, and will be reported at a later date.

Institute of Marine Engineers (Inc.).—In the course of a paper on "Aids to Prevent a Ship from Sinking," read on November 13th, Mr. C. V. A. Eley advocated the provision of ample pumping capacity to clear out the water as fast as it entered a damaged compartment. This could be effected by providing sufficiently large suction pipes from the bilge to the centrifugal circulating pumps, and by fitting the electric lighting engines with centrifugal pumps. In his own system, he used direct pumping plant with central means of indicating the position and extent of the damage and of controlling the pumps. The discussion was adjourned to December 11th.

Chadwick Public Lectures, Leicester.—The third of the Chadwick Lectures on "Electricity and National Welfare" was given at the Museum, Leicester, by Prof. H. T. Davidge, on Saturday, December 1st, the special subject dealt with being "Electricity and the Hygiene of the Body." The lecturer stated that we were much in the dark as to the action of electricity upon the body, but certain purely physical and chemical results caused by the passage of a current through living beings were well established. He then dealt with electric shock, the use of X-rays for examination and curative treatment, the principles and uses of ionic medication, the brush discharge, and electric baths, and applications of electricity and magnetism to the removal of foreign bodies from wounds, and finally an elementary treatment of the properties and uses of radium for medical purposes was given.

Royal Society.—At the meeting, on Friday last, Sir Joseph J. Thomson was elected president. The treasurer and other officers were elected in accordance with the list published in our issue of November 9th.

President Wilson's Speech.—In the course of his speech delivered to the U.S. Congress, on Tuesday, President Wilson, in referring to necessary new legislative and other war measures, said:—"It is imperatively necessary that the consideration of the full use of the water power of the country, and also the consideration of the systematic, and yet economical, development of such of the natural resources of the country as are still under the control of the Federal Government, should be immediately resumed, and affirmatively and constructively dealt with at the earliest possible moment. The present need of such legislation is daily becoming more obvious. The legislation proposed at the last session with regard to regulated combinations among our exporters, in order to provide for our foreign trade a more effective organisation and method of co-operation, ought by all means to be completed at this session."

Mine Electricians' Exemptions.—Under arrangement with the Miners' Federations, all certificates of exemption issued on grounds of employment to electricians of military age employed at coal mines who entered the coal mining industry after August 4th, 1914, and wer of military age at that date, have been withdrawn.

"Natural Steam" Electric Generating Plant in Italy.—In the volcanic areas of the Province of Tuscany (Italy) there are numerous hot springs from which immense columns of steam issue. In the current (September) number of *La Science et la Vie*, the electrical engineer of the company (Società Boracifera di Lardarello) which has been formed with a view to the practical utilisation of this natural steam, discusses the methods adopted for this purpose. Boreholes are made at suitably selected places in order to collect the steam, and are lined with cast-iron. The steam cannot be used direct for power raising owing to the presence of incondensable gases. Use is made of a series of evaporators, consisting of nests of tubes in a special vessel. The subterranean steam is led into this vessel, and heats the water contained in the tubes. The pressure of the natural steam is about 40 lb./sq. in., and of the steam in the tubes about 30 lb. The steam turbine, constructed for a pressure of about 24 lb./sq. in., runs at 3,000 R.P.M.; it is coupled to a three-phase, 250-KW. alternator, working at 50 cycles and 4,000 volts. The current is stepped up to 16,000 volts, and is fed to an aluminium tranamission line feeding an area of about 25 miles. It supplies energy to the town of Volterra and to various factories in the vicinity. For factory purposes the pressure is stepped down to 220 volts. This plant started woking in 1913, and is giving entire satisfaction.

This first installation led the promoter to consider the construction of a higher-powered plant, which was brought into use in 1916. The war naturally caused difficulties in obtaining delivery of the necessary plant, which increases to 7,500 KW. the capacity of the new station. A French firm was given the task of designing the evaporators for producing the pure steam for working the turbines. They may best be compared to a multi-tubular boiler, in which the flame surrounds the tubes. The new station comprises 16 evaporators, to be soon supplemented by six others, each capable of generating 6,000 kg. (13,500 lb.) of pure steam per hour, at an effective pressure of about 8 lb./sq. in. The natural steam arrives at a pressure of 14·7 lb./sq. in., and condenses in the chamber surrounding the tubes. It is impossible to eliminate the sulphur dioxide mixed with the steam from the "soffioni" (as the natural steam jets are called), so that the tubes in the boiler have had to be made of aluminium to prevent incrustation.

Finally the pure steam produced in the evaporators is led into the turbines after having been superheated by a further supply of natural steam.

Three turbo-generator groups have been installed, each of which has an effective output of 2,500 KW. The turbines are of the reaction type, and work at an effective pressure of 0·25 atm. (3·6 lb./sq. in.) at 3,000 R.P.M., and each consumes about 30,000 kg. (66,000 lb.) of steam per hour.

The turbine condensers are of the surface type. Pumps of 350 H.P. for each machine circulate the water for cooling the condenser tubes; they deliver 1,200 cb. metres (42,378 cb. ft.) per hour.

The turbines are coupled to three-phase, 3,000-KW., alternators, supplying current at 4,000 volts, 50 cycles. The pressure is raised to 36,000 volts for distribution.

The transformer house contains four three-phase transformers, each of 2,850 K.V.A., and two others of 4,000 K.V.A. will shortly be installed. The pressure can easily be stepped up to 40,000 volts.

The company mentioned above owns other "soffioni" (hot springs), which contain a less proportion of corrosive gases, and experiments will be made with a view to utilising the natural steam direct, thus obtaining greater efficiency.

Trade Matters Before Parliament.—In the House of Commons, on Monday, Sir Albert Stanley, President of the Board of Trade, moved the second reading of the Non-Ferrous Metal Industry Bill. The rejection of the Bill was moved and seconded. In reply to discussion, Dr. Addison showed that the Bill involved questions of national safety and the increased development of essential raw materials. He showed how for 18 months the Ministry of Munitions were trying to escape from the toils of the German monopoly. Without such powers as the Bill would give it would be practically impossible to form any competing organisation. The discussion stood adjourned.

The Import and Export Control Bill, which proposes the exercise of its powers for three years after the war, is understood to be meeting with strong objections from commercial interests in the House, and the Government may reduce the period to one year.

The *Daily Chronicle* Parliamentary Correspondent states that the final report of Lord Balfour of Burleigh's Committee on Trade Policy will be published in the course of a few days. It is understood that its principal recommendation will be the imposition of a general tariff on all imports, with the exception of food commodities. "The import duty proposed is 10 per cent. *ad val.* This would be reduced by negotiation to those countries who gave British goods reciprocal treatment. Presumably imports from the Dominions and India would be admitted free."

Holt v. A.E.G. Electric Co., Ltd.—On Tuesday, in the Chancery Divison, Mr. Arthur Holt, formerly London manager of the A.E.G. Electric Co., Ltd., claimed for a liquidated sum representing salary up to the end of November 30th, 1918, the date when he calculated the war would end. Plaintiff, who is with the Forces at the Front, claimed damages by reason of the fact that the contract for his services had been determined since the company had been ordered to be wound up by the Board of Trade. It was stated for the Board of Trade that they thought that directions should be given to the Controller to make a payment in settlement of the claim, but a decision was asked for on the point as to whether the action would lie against the company. Mr. Justice Younger said he would give a written judgment.

The I.M.E.A. and Station Engineers.—A circular letter has been sent out by the hon. secretary, Incorporated Municipal Electrical Association, drawing attention to (*a*) the position of electrical undertakers as regards the difficulty of retaining the services of their technical assistants; (*b*) the tendency in the past to underpay engineering assistants; and (*c*) recommending, as a first step, that the bonus awarded by the Committee on Production should be paid (where this has not already been paid) to all members of the staff, and suggesting that the general question of remuneration of the technical staff should receive the earliest possible attention.

Gas Traction Committee.—It is officially announced that the Government has appointed a Committee to consider and report on matters arising from the substitution of gas for petrol, &c., as a source of power, especially in motor vehicles. We note that Mr. Shrapnell Smith, who occupies the position, amongst others, of vice-chairman of the Electric Vehicle Committee of Great Britain, is to act as secretary for the time being.

P.O. Tube Railway.—The Board of Trade has extended by one year the time for the completion of the P.O. (London) Railway authorised by the Act of 1913.

Meter Accuracy on Arc Furnace Loads.—In electric arc furnaces used in making high-grade steel, the current wave shape is at times greatly distorted. A member of the Committee on Meters of the Technical and Hydro-Electric Section of the National Electric Light Association reports that the accuracy of an induction meter on this service was questioned because the magnetic and electrical characteristics of iron vary somewhat with the shape of the current wave. On account of the rapidly fluctuating load, indicating instruments could not be used; dynamometer type watt-hour meters without any iron in their magnetic circuits were specially compensated for inductive loads and used as standards, and the readings of the induction type watt-hour meter compared therewith. The meters were installed on the secondaries of current and voltage transformers. A large number of tests were taken under various conditions of furnace operation, and the dynamometer and induction type meters agreed to within 1 per cent. The instrument transformers were tested by the Electrical Testing Laboratories under artificially distorted wave forms, and were found to be accurate. The laboratory wave forms were not quite as irregular as the actual furnace current waves, but were severely distorted, and as they produced no appreciable effect on the transformer accuracy it was assumed that the effect of the slightly greater irregularity in the furnace wave would be negligible. It was concluded that under the conditions existing in this installation the accuracy of registration of the customer's meter was well within commercial limits, and was not seriously affected by the irregular wave form.

It is important to note that in the furnace electrode circuits considerable direct current was present, due probably to rectification in the arc, and consequently the current wave shape was unsymmetrical with respect to the zero line. The general shape of the wave was such as would be produced by superposing direct current on alternating current, and it was found that current transformers had large errors on this type of wave. If, therefore, the customer's meter had been placed in the secondary circuit of the supply transformers, instead of in the primary, serious errors in registration would probably have resulted. Pending further investigation, it is therefore recommended by this Committee that if arc furnace loads are metered on the secondary side of the supply transformers, the accuracy of the metering should be investigated. If metered on the primary side of the supply transformers errors will be avoided, as the direct current in the electrode circuits cannot reappear on the primary side, hence the primary current wave is symmetrical with respect to the zero line. Summing up the results, it appears that no serious error is produced by an irregular current wave form; but if the wave is unsymmetrical with respect to the zero line, considerable error may occur.—*Metallurgical and Chemical Engineering.*

Russian Electricity Supply.—Right to Vary Agreements.—The dearness of materials and labour, says a semi-official journal, has made it necessary to increase the price of finished products in Russia, even in cases under Government control. This applies particularly to electrical concerns that are bound by concession agreements with the towns. The normal solution of this would appear to lie in a review of the concession agreements. Experience, however, has shown that agreements cannot always be arrived at between towns and concessionnaires, and in the cases of losing concerns such have been looked upon as in a condition facilitating the earliest possible transfer of such concerns to the control of the towns on an advantageous basis to the latter. On the other hand, the contractors have not always shown an inclination to review their agreements on the basis of safeguarding the interests of the towns. The fear of a disaster to the electrical industry, which threatened to leave the towns and industry without electric light and power, prompted the Ministry of Trade and Industry to inquire into the matter and to seek means for the protection of the electrical industry. The Ministry of Trade and Industry found a ready support in the Ministry of Foreign Affairs, which, being interested in the fate of foreign capital, particularly Belgian, invested in the electrical industry, brought the question to the notice of the Provisional Government. As the result of a conference a project was prepared for varying the agreements as to the delivery of current by the public electricity stations. This project embraces the following conditions:—

All stations for public use are permitted to raise the tariffs for energy inscribed in the concession agreements, as well as tariffs according to separate agreements within the limits of the maximum fixed by decree. An explanatory notification of the increase is to be delivered to the respective towns; but if an agreement is not reached in a month the new tariff announced is to come automatically into force from the date of the delivery of the declaration; whilst the town will only have the right until the expiration of six weeks from the date of the delivery of the notification to oppose such increase at the Ministry of Trade and Industry, which, after deliberation, will decide the question finally.

If the increase in the tariffs should raise the net profits over 9 per cent. the surplus is to be divided between the Government (90 per cent.) and the town (10 per cent.), whilst the superintendence rests with the Ministry of Finance, which may inspect and revise the books and business methods of the interested concerns. The decree is to remain in force until December 31st 1918.

The project referred to will no doubt decide the question in a radical form. If it comes into existence the electrical industry will be completely freed from the possibility of any efforts of the towns to influence their activity in any way. This would be attained at too high a price: namely, by the complete destruction of the rights and contempt of the interests of the towns. Such a solution goes far further than the object immediately aimed at by the decree.

An Institution of Electrical Station Engineers.—On Wednesday evening a meeting was held at St. Bride's Institute to discuss the reconstitution of the A.E.S.E. on the new basis formulated at the Hammersmith meeting. Mr. H. W. Healy, president of the London Committee of the A.E.S.E. and hon. secretary of the Provisional Committee, occupied the chair, and opened the proceedings with an explanatory statement regarding the purpose of the reconstitution and the object of holding the meeting.

Mr. W. A. Jones, hon. secretary of the A.E.S.E., then read a report on progress to date, and Mr. G. C. Law, of Barnes, delivered an admirable address on the functions of the electricity supply engineer, the ideals at which he should aim, and the status to which he was justly entitled. The chairman then threw the matter open for discussion, and answered a number of questions which were put to him by members of the audience. There was a very large attendance, numbering perhaps 120, and some useful suggestions were put forward. Much interest was shown in the question of qualifications for membership, and it was urged that the Association should secure the support of the senior men before enrolling the juniors, instead of adopting the reverse procedure, as at present.

The Electro-Harmonic Society.—The next smoking concert will be held at the Holborn Restaurant, in the Venetian Chamber, on Friday, December 14th, commencing at 8 p.m. Mr. H. Scholey will preside. Artistes: Mr. Philip Ritte, tenor; Mr. George Baker, baritone; Mr. Olly Oakley, banjo soloist; Mr. Arthur Melrose, comedian; Mr. Reginald Wishart, illusionist; Mr. Warwick Pryce, musical sketches at the piano; Mr. Bernard Flanders, A.R.A.M., solo pianoforte and accompanist.

Wages in Metropolitan Electricity Works.—The Marylebone Electricity Committee, reporting to the Council with regard to the recent conference of electrical supply companies and corporations, called to discuss the various awards which have been made from time to time by the Ministry of Labour, and which related to electricity supply employés, after quoting the resolution passed at the Conference (printed on page 521 of our last issue), states that the resolution has not yet become operative, and that the question has been referred to Sir George Askwith, with the view that he should issue an award on such lines in order that employés at all electrical power stations should be treated in a similar manner. A further meeting of the Conference is to be held.

Appointments Vacant.—Chief assistant electrical engineer, for Birmingham Corporation (£750); junior shift engineer for the Borough of Barnsley Electricity Department. See our advertisement pages to day.

Educational. — Birmingham. — Owing to the great increase in numbers of students in the Electrical Engineering Department of the Birmingham Technical School, and particularly in connection with the wireless telegraphy classes, the City Council has obtained additional temporary school accommodation at Ludgate Hill.

Leeds.—The Secretary for Education in Leeds invites applications for the position of teachers of electricity, electrical engineering, and electric wiring work in connection with the Leeds Technical School. Applications to the Principal of the Technical School, Cookridge Street, Leeds.

Woman Electrician Wanted.—A woman electrician is urgently wanted to take charge of the lighting installation in a country house, with dynamo and accumulators. A man operates the steam engine which drives the dynamo. A knowledge of wiring, &c., is required. Wages, 35s. to 37s. a week, with lodgings. We believe this is the first instance in which a female attendant has been inquired for.

Inquiry.—A correspondent seeks information regarding engines running on sewer gas; also apparatus or processes which could be worked in conjunction with a producer gas-engine electricity works generating direct current, such as plant for briquetting anthracite dust, coverting clinker into paving slabs, electric welding, &c.

REVIEWS.

Spons' Electrical Pocket Book. By W. H. Molesworth. London: E. & F. N. Spon, Ltd. Price 6s. net.

There are many pocket-books for engineers in existence, but up to the present we do not remember having seen one so useful for electrical engineers as the one now before us. To a large degree the test for such works lies in the numerous occasions for reference that are always cropping up, but before reference can be made, it is necessary for one carefully to peruse the pages of the book under consideration. This procedure would appear necessary for all technical works, but in the case of a "pocket-book," the reader's glance, if any, is usually most casual, so that the actual utility of such a book is then limited through the ignorance of its owner.

In "Spons'" much of the matter will be found to be of more than passing interest, for there are many pithy articles to be found within its pages. A comprehensive index certainly assists one's search, but at the same time individual study is recommended for those who purchase this volume or similar ones.

The book opens with tables of weights and measures, with full details for metric conversion, and other useful tables, too numerous to mention, follow. The Italian graphic symbols are worthy of study and adoption by those who believe in progress, and their inclusion should do much to assist in their international propagation. The careful explanation of terms and fundamental principles will assist the student, while the tables relating to the heating of wires, &c., will meet with the needs of even an expert.. Resistances and conductors are fully dealt with and exhaustive data given. Contractors and wiremen are catered for, inasmuch as there is a great deal of information which should be of use to them. Board of Trade and Home Office Regulations are fully given, and later on other standard regulations and rules are reprinted, including those of the I.E.E. The collection of such items under one cover makes the book an extremely handy work of reference. Transmission is handled in a masterly manner, as also is testing. Magnetism and electromagnetism are set forth in an understandable way, so that even a beginner could appreciate the text and diagrams relative to electrical machinery, regarding which many valuable data are set out, the particular section finishing up with the British Standardisation Rules.

Details relative to alternating current next appear, theoretical and practical considerations relating to the principles involved being given, as in the previous sections. Applications of electricity to lifts, machine tools, and electric vehicles are next treated, much of practical use being given concerning accumulators; regarding electric furnaces and electrochemistry the information appears to be somewhat meagre, but no doubt the next edition of the work will show changes in this respect. The pages devoted to illumination could be improved without much difficulty, since it would appear that matter has been added without due respect to terms previously quoted. The "trade" is also in evidence in this section.

Practically the whole of the remainder of the book is devoted to electric traction, and we are inclined to think that much contained therein might have been cut out with advantage, as the space represents about 30 per cent. of the whole. It is true that electric traction is likely to be of the utmost importance, but there are signs that other branches are developing at an even greater rate, and we should therefore like to see such a book as this rather more general than at present. To those connected with electric railways and tramways "Spons'" will appeal most, but at the same time it is a volume which may be appreciated and utilised by all whose work demands even the slightest knowledge of electricity.

The editor is to be congratulated upon the systematic manner in which it is arranged; the diagrams are very good, and errors are rare.

Hydro-Electric Power. By Lamar Lyndon. Vol. II. Electrical Equipment and Transmission. London: Hill Publishing Co. Price 15s. net.

In this volume generators, transformers, and switchboards are discussed in considerable detail, and a great deal of information is given on the subject of transmission lines.

The operating speed of a water-wheel is determined within a limited range by the head of water and the power. The periodicity is also limited by the wheel speed, thus at the Keokuk plant 25 periods was chosen for the 10,000-h.p. units because the low head of water gave a very low speed, namely, 57.7 r.p.m.

On the other hand, for a moderate or high head fall a higher periodicity than 25 cycles per second is desirable, because the latter would cause the generators to have a small number of poles, and the rotor to be of small diameter and great length.

Maximum rating of generators is defined as the maximum continuous load which they will deliver with a temperature rise of 50 per cent., no allowance being made for overload capacity. It is stated that up to about 13,000 volts, generators may be directly connected to the line, and that the capacity of a generator wound for that voltage will be 30 or 40 per cent. lower than if wound for 2,300 volts, because of the extra space taken up by insulation.

In discussing the methods of driving exciters, it is pointed out that if driven by a small auxiliary water-wheel, as the size is small, the wheel is usually inefficient. By driving the exciter with a synchronous motor, the motor may be used to improve power factor. If this is done it is necessary to have at least one other exciter driven in another way, so as to start up the plant. In some cases storage batteries are installed for use in an emergency, in case of breakdown of one or more exciters.

Transformers.—When a transformer has water cooling coils the amount of water required is dependent on the losses of the transformer, and it is usual to allow ½ gal. per minute per kw. loss. When a transformer is air-cooled it is usual to allow about 150 cu. ft. of air per minute per kw. loss. One kw. will raise the temperature of 1,650 cu. ft. of air at atmospheric pressure 1 deg. C. per minute.

Condenser type terminals of transformers are built up of alternate layers of insulation and of thin metal. The metal layers form equipotential surfaces which distribute the potential between the terminal and the ground in direct proportion to the insulation strength of the material used, provided, of course, that the thicknesses of layers of insulation and the lengths of the layers are correctly proportioned. Each layer of insulation, with its metal layers, acts as a condenser, and thus the completed terminal consists of a number of condensers in series distributing the potential in proportion to their relative capacities.

If single-phase transformers are used, it is possible to connect in circuit two such transformers instead of three; in case one breaks down, the two will carry 58 per cent. of the load (not 67 per cent.) with the same heating as before the breakdown. The two will not parallel successfully with a three-unit bank, because the regulation is worse, and the voltage drop on one of the phases is slightly greater than on the other two.

The delta star connection is widely used for raising generator voltage to line voltage, and it is usual to ground the neutral on the high-tension either directly or by a resistance. Since 1913 the tendency has been towards using outdoor-type transformers, as this practice is more rational than having transformers inside an expensive building.

In warm climates, where the temperature in the sun may reach 135 deg. C., the ability of the transformers to radiate heat is diminished. Therefore, for such situations a shed should be built to shield them from direct rays of the sun.

Switchboards.—The chapter on switchboards is good, and includes the specification of a 5,000-kw., 2,300 to 44,000-volt switchboard, also one for 46,000-k.v.a., 6,600 to 110,000 volts. It is stated that brass and copper pipes are being used in many installations for high-tension bus-bars and connections. Particulars are given of submerged iron-wire rheostats for testing purposes, and it is stated that three tanks, each 6 ft. by 4 ft. by 2 ft. deep, will effectually cool resistance coils absorbing 2,000 kw. at 6,600 volts. A rubber hose-pipe feeding a 1¼-in. stream of water into each tank will keep the water sufficiently cool.

Transmission.—On the question of aluminium *versus* copper for transmission lines, the author favours the first-named, the advantages being: (*a*) Aluminium costs less than copper; (*b*) for a given resistance or given cost, aluminium is larger in diameter, and this tends to reduce the corona effect on high voltages; (*c*) the better radiation gives a lower temperature under load, thereby slightly reducing resistance; (*d*) the larger conductor is more mechanical; (*e*) the surface of aluminium oxide sheds sleet better than does copper; (*f*) the lighter weight lowers freight charges and cost of transporting along the line on reels.

Aluminium alone is not adapted for lines in which the spans are great and the cables small, because the metal sags so much at high temperatures. Cables may snake or whip under sudden gusts of wind, which means that all the cables on a pole may not sway together. By losing their normal separation they come too near, and may even make contact. These objections have been largely overcome by providing aluminium cables with steel cores. Formulæ are given for bimetallic wires, and it is stated that one made of aluminium and steel costs nearly as much as a copper conductor for the same power.

Dwight's chart for the quick computation of transmission lines is included.

Poles.—The author prefers wood or concrete poles to steel poles for transmission lines, and, as the latter are conventional practice with many engineers, there is a complete discussion of the subject. Comparative estimates of tower lines and pole lines are given, and there are some very full specifications.

A valuable chapter of transmission calculations contains data on corona effect, surge voltages, transposition of wires, &c.—E. K. S.

Principles and Practice of Electrical Engineering. By Alex. Gray, Whit.-Sch., M.Sc. Second Edition. London: Hill Publishing Co., Ltd. Price 12s. 6d. net.

When we reviewed the first edition of this work a few years ago we described it as bearing "the hall-mark of sound

experience, and accurate, complete knowledge of the science . . . . one of the best books on electrical engineering that any kind of engineering student could wish to study from." Naturally, the new edition is no less worthy of our encomiums. It has not been greatly changed, the additions consisting mainly of a considerable number of problems relating to the contents of the respective chapters; these are all collected at the end of the book, and appear to be admirably adapted to make the student think, and to impress the leading facts upon his memory. The desirability of adding such a collection of examples was pointed out in our previous review. The treatment of armature windings has been recast, to show more clearly the transition from the Gramme to the drum type of winding; minor changes have also been made in the chapters on alternating current circuits, and in the treatment of the force acting on a conductor carrying current in a magnetic field. As a whole, however, the book is practically identical with the earlier edition, and the author is to be congratulated upon the thoroughness with which his work was accomplished in the first instance, which has left so few loopholes for improvement. We cordially recommend the work to engineering students; it is one of the few selected volumes which we always keep within arm's reach.

Laws of Physical Science. By Edwin F. Northrup, Ph.D. London: J. B. Lippincott & Co. Price 8s. 6d. net.

This is a book of much originality, being nothing less than an attempt to put under one cover a full list of the general propositions or laws of science. Every student of the sciences is, of course, familiar with the data pertaining to those sciences—they are to be found in many manuals—but this work goes much beyond that sort of thing. It gives the laws underlying the data. The author hopes that students "will not only find guidance, but will also derive inspiration by having before them under a single view the very epitome of the world's heritage of the fundamentals of its knowledge and wisdom."

Although the title of the book refers to the *laws* of physical science, the author has found it a difficult matter to say just what *are* laws. So, in order that nothing possessing any claim to the dignity of a law should be omitted, many general propositions, theorems, and mere statements of important facts have been included.

The general statements have been classified in six sections:—I, mechanics; II, hydrostatics, hydrodynamics, and capillarity; III, sound; IV, heat and physical chemistry; V, electricity and magnetism; VI, light.

The system of stating the laws, propositions, and theorems is as follows:—There are some 189 pages in the book, and on an average about three statements are given per page. Each law is plainly marked by a title in large type. Then there follows a brief explanation in words and, if necessary, in mathematical symbols. The account finishes with references to easily accessible text-books, and in some cases to original articles or papers. The method is best understood by considering an example. Taking Section I, Mechanics, and turning to page 19, we find:—

Young's Modulus.

By "Young's Modulus" is understood the force which would be required to stretch a body of unit cross-section to double its length if such lay within the elastic limit. It is a constant for any one material.

$$\text{Thus, Young's Modulus} = M = \frac{L F}{e a}$$

where L = length of body (usually a wire),
a = area of cross-section.
F = stretching force applied,
e = total elongation produced by F.

Similar moduli hold for compression, flexure, and torsion. (Crew, *General Physics*, p.131. Also *Ganot's Physics*, *art.* 87. Also Thomson & Tait, *Treatise on Natural Philosophy*, Part II, *arts.* 686-688.)

At the end of the book there is an alphabetically-arranged bibliography of all books and journals referred to, and a very full index with duplicated references, so as to aid in the quick location of subject matter.

There can be little doubt that the idea underlying the work is a good one. Advanced students of the sciences, especially those engaged in research work—and we are likely to hear quite a lot of this kind of work in the near future—will find it useful to be able to look up any fundamental law or conception in any branch allied to their own, without the necessity of hunting through a library. And, moreover, such a work as this is welcome nowadays when none of the sciences can any longer be locked fast into a separate compartment, for one shades off into another, and no man can define the border line.

Patent Extension Application.—Sir James Dewar, F.R.S., LL.D., is applying for an extension of term for Patent No. 13,638/1904 for his invention "An improved method of absorbing gases and the application thereof to the production of high vacua and the separation of gases."

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the Electrical Review *posted as to their movements.*

Central Station Officials.—The Morecambe Corporation has increased the salary of its electrical engineer by £30.

The Walthamstow U.D.C. has granted the following increases of salaries to officials in the electricity department:—Mr. G. J. Hollyer, £35 per annum; Mr. T. F. Lymn, £25 per annum, without bonuses; Mr. G. W. Stubbings, £10 per annum, with bonuses; Mr. W. H. Arnold, £10 per annum.

Mr. W. J. Cox has been appointed works manager at the Derby electricity works, at a salary of £240 per annum, in place of Mr. W. C. Dinn, resigned.

Mr. F. R. Hobley, mains engineer to the Lowestoft Corporation electricity department for the last 10½ years, has been appointed electrical engineer to the New Van Mining Co., of Llanidloes, South Wales, and has already taken up his new duties. On leaving Lowestoft he was presented with a memento, the presentation being made by the chief engineer on behalf of the whole of the staff and employés.

General.—Sir John Turney has retired from the chairmanship of the Nottingham Corporation Electricity Committee after occupying that position for over 25 years. He is succeeded by Mr. R. H. Swain. At the last meeting of the Committee, Mr. H. Talbot, the city electrical engineer, was presented with a silver rose bowl, the gift of Sir John Turney. Mr. Talbot has been associated with the undertaking for 25 years. Sir John has also presented a silver rose bowl to Mr. A. Brown, the city engineer, on the completion of 50 years' service.

Mr. H. R. Pyke has resigned his position with the India-Rubber, Gutta-Percha & Telegraph Works Co., Ltd., and joined the staff of Messrs. S. G. Leach & Co., Ltd., as manager of their motor department.

The Birmingham City Council on Tuesday appointed Mr. W. Brew, M.Inst.E.E., head of the electrical engineering department of the Municipal Technical School at £400 per annum, in place of Mr. E. O. Turner, B.Sc., resigned.

Prof. F. W. Burstall, Professor of Mechanical Engineering at the University of Birmingham, has been appointed gas examiner, in the place of the late Mr. Cresswell, at an annual salary of £200

Ald. Smith has been re-elected chairman, and Col. Wadham (at present with the Forces) vice-chairman, of the Barrow Corporation Electricity Committee.

We desire to congratulate Mr. George Sutton upon his election to the chairmanship of the important concern with which he has for the past 36 years been so prominently associated—W. T. Henley's Telegraph Works Co., Ltd. Mr. Sydney Gedge has been a director of the company for 37 years, and for 30 of these he has acted as chairman. His genial presence at the company's meetings has always engendered great good humour, and his speech has generally formed a suitable introduction to the very practical informing remarks with which Mr. Sutton, as managing director, has acquainted the shareholders with the actual situation of the electrical industry so far as it was represented by Henley's. Mr. Gedge, owing to advanced age, has decided to relinquish his position as chairman as from January 1st, 1918, but the company will still have the benefit of his long experience on the board. Mr. Sutton will henceforth hold the position of chairman and managing director. For Henley's, as for all important electrical industrial undertakings, the coming years will bring innumerable problems, but those who remember how well the concern was piloted through the troubled period of several decades ago, and who have followed its uniform progress for a good many years past, will feel assured that with the experienced leader of the past 36 years at the helm the concern will know well how to avail itself of the very great opportunities that will present themselves for the display of progressive and successful enterprise.

Roll of Honour.—The death in action is reported of Corporal H. C. Hammond, of the Tank Corps. He was formerly in the service of the Lytham Tramways Co.

Private Tom Scott, who was formerly employed at the Leeds electric power station, has died of wounds received in action.

Second-Lieutenant Ernest S. Learoyd, Middlesex Regiment, who has been killed in action, aged 28 years, was with Messrs. A. Learoyd & Son, metal merchants, Clapton.

William Edwards, an employé of the Barrow Corporation electricity department, has fallen in action.

Corporal G. Beadle, formerly of the Scarborough Tramway Co.'s staff, who has been wounded, has been awarded the Military Medal.

Gunner J. O. Donovan, R.H.A., formerly on the staff at the Brompton & Kensington electricity station, has been killed in action.

Second-Lieutenant Vincent H. M. M'Mahon, Mechanical Transport, A.S.C., who appears in the list of officers mentioned by Lieutenant-General Milne, Commander-in-Chief of

the British Salonica Forces, for gallant conduct and distinguished services, is the son of Mr. J. J. M'Mahon, electrical engineer, Manchester Corporation tramways. Previous to the war he was engaged in the rolling-stock department of that undertaking.

Private R. GEE, South Lancashire Regiment, formerly missing, and now reported killed, was prior to enlistment employed by Messrs. Charles Macintosh & Co., electric wire and cable manufacturers, Manchester.

Lance-Corporal J. B. HAMILTON, H.L.I., who has received the V.C. for most conspicuous bravery and devotion to duty, was employed in the electrical department of the Steel Co. of Scotland, Ltd., at Hallside, Cambuslang, for many years, and prior to joining the H.L.I. he was employed for six months with the Electrical Co., in Pitt Street, Glasgow.

Sergeant A. APPLETON, King's Own Yorkshire L.I., reported wounded and missing a year ago, is now officially reported killed. He was employed by Messrs. Vlasto, Clark and Watson, electrical engineers, Warrington.

Gunner J. SHAW, R.G.A., killed in action, was in the employ of the Tudor Accumulator Co., Dukinfield.

Motorman A. A. ALLEN, of the West Ham tramways, who was promoted in June, 1917, to the rank of Second-Lieutenant in the 13th Royal Fusiliers, has been granted the Military Cross for conspicuous service on October 4th, when, after all other officers of his company were put out of action, he took charge and held the position for 48 hours.

Sergeant T. BARCLAY, who was employed on the Glasgow Corporation tramways, has been awarded the Military Medal.

NEW COMPANIES REGISTERED.

Armorduct British Co., Ltd. (148,980).—Registered November 26th. Capital, £50,000 in £1 shares. To acquire by licence of the Board of Trade the undertaking of the Armorduct Manufacturing Co., Ltd., the books and documents of which are liable to inspection under Section 2 (2) of the Trading with the Enemy Act, and to carry on the business of electrical engineers, electricians, manufacturers of and dealers in internal-combustion engines, conduits, tubes, wires, cables, pottery, rubber, guttapercha, and metals, &c. Purchase of considerations, £15,500 in cash, of which £50 is allocated to goodwill. The subscribers (each with one share) are:—H. A. Marsh, Ash Cottage, Gravelly Hill, managing director; G. C. Busgell, 76, Handsworth Wood Road, Handsworth, Birmingham, managing director; W. H. Glassey, "Overley," Station Road, Yardley, managing director; A. D. Tipper, Hamstead Hill, Handsworth, ironfounder; G. A. T. Legg, Penybryn, Sedgley, near Dudley, managing director; G. H. Fraser, 757, Royal Liver Building, Liverpool, export merchant; J. D. Burnside, 45, Lawley Street, Birmingham, secretary. Minimum cash subscription: 100 shares. The articles contain the usual provisions for excluding enemy holdings or foreign control. The first directors are:—H. A. Marsh, W. H. Glassey, A. D. Tipper, G. A. T. Legg, and G. H. Fraser. Registered office: Bathurst Works, Witton, Birmingham.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Cutting Bros., Ltd.—Memorandum of satisfaction to the extent of £2,900 on September 27th, 1917, of debentures created June 20th, 1916, securing £3,450, has been filed.

Gambrell Bros., Ltd.—Land Registry Charge on leasehold laboratories and works in Southfields, S.W., dated October 30th, 1917, to secure all moneys due, or to become due, from company to National Provincial Bank of England, Putney.

James Keith & Blackman Co., Ltd.—Memorandum of satisfaction in full on November 17th, 1917, of debentures dated December 5th, 1902, securing £2,400, has been filed.

CITY NOTES.

Amazon Telegraph Co., Ltd.

Mr. C. W. PARISH presided, on November 27th, at the annual meeting, held in London. He said that, compared with the previous year, the improvement shown in the report was quite satisfactory. The rubber crop of the Amazonas district had increased slightly. During the year the highest and lowest quotations for fine hard Para rubber were 3s. 7d. and 2s. 8½d. per lb. respectively, and for the greater part of the time the price was over 3s., whereas during the previous year it fluctuated between 4s. 1d. and 2s. 4¾d. The traffic receipts of the company showed an increase of £8,940, or over 19 per cent. The gross revenue showed an increase of £10,557, or over 17 per cent. The total working expenses increased by only £711, or less than 2¼ per cent., which was not large considering the general rise in prices which had taken place all over the world. The result was that the net revenue showed an increase of £9,846. They had been able to add 1 per cent. to the dividend, and to carry forward about £400 more. The investments now amounted to £54,313, an increase of £38,839. They invested a total of £50,000 in British Government securities. In the current year, the traffic receipts up to the present were nearly £3,000 higher than those for the same period last year. The prospects for this season's rubber crop were believed to be good. If their expectations materialised he thought they might confidently look forward to having at least as good a year as the one they had just passed through. A portion of the company's revenue was derived from a service of local deferred messages, which was instituted in July, 1914. These messages were subject to a delay of not less than 10 nor more than 24 hours, and up to September last year were carried at half-rate. The directors, however, were not very satisfied with the result of the experiment, as although this class of traffic at first showed signs of expanding, it ultimately fell away considerably. They decided, therefore, to make a further reduction in the rate, which came into force in October last year, and as a result there was a very satisfactory increase in the number of local deferred words transmitted, the receipts having increased by nearly £3,000 as compared with the previous year, and they hoped to see a further expansion during the current year.

Allgemeine Elektrizitats Gesellschaft.

The report of the directors for the year ended June 30th, 1917, states that the whole of the company's activity was devoted, as in the preceding year, to the problems raised by the war, the multiplicity and extent of which would be reserved for mention in the future period of peace. At present the company would have to limit itself to the statement that the orders received and the deliveries effected were considerably greater than in 1915-16. The superficial area covered by the workshops in full operation had risen from 203,874 square metres to 808,881 square metres, and the number of employés at the end of the financial year had advanced to 79,293.

The machine sets in construction in the turbine factory comprised those of powers rising to 50,000 KW., whilst the machinery works had carried out the largest types of transformers hitherto made, namely, of 60,000 KW. and 110,000 volts, and was continuously occupied with the production of high-tension material. In wireless telegraphy important innovations were developed, and the deliveries of the apparatus factory exceeded the figures for the previous year. It was possible for the glow-lamp branch to bring sale prices into better proportion to the costs of production. The aeroplane department, for which workshops had been erected at Hennigsdorf, and at Johannisthal on the Upper Spree, was carrying out work which afforded satisfactory prospects also for peace times.

The demand for electrical machinery and apparatus for war industries, particularly the chemical industry, was exceptionally active. Remunerative orders were also received from the coal mines, whilst the iron and steel works continued to require electrical equipment, especially large rolling train drives. The central-station department completed the Gerstein works in Westphalia with a capacity of 30,000 KW., and the power station at Zschornewitz, in the lignite district of Bitterfeld, for the Electro Works Co., and the power station at the Fortuna mine was enlarged by 8,000 KW. The Ferro-Silicon Works of Elverlingen placed an order for a complete sinking plant with a transformer output of 14,000 KW., and the Bavarian Nitrogen Works Co. and the Silesian Electricity and Gas Co. gave contracts for turbo-dynamos of large dimensions. In the case of the railway department, the activity was almost exclusively applied to the production of replacement plant for existing lines, and the work on the A.E.G. high-speed railway in Berlin was temporarily restricted. The accounts show the following figures for the past four years, 20 marks being assumed as the equivalent of £1 sterling:—

	1913-14.	1914-15.	1915-16.	1916-17.
Share capital	£7,750,000	£7,750,000	£9,200,000	£9,200,000
Gross profits	1,132,000	1,544,000	1,987,000	2,339,000
General expenses	73,000	73,000	91,000	103,000
Taxes	106,000	146,000	143,000	195,000
War allowances	—	230,000	377,000	567,000
Depreciation	44,000	44,000	45,000	55,000
Net profits	908,000	1,028,000	1,324,000	1,478,000
Net profits, including balance forward	944,000	1,064,000	1,359,000	1,518,000
Directors' fees	23,000	27,000	28,000	34,000
Bonuses to staff	60,000	75,000	100,000	100,000
Pension fund	50,000	75,000	100,000	100,000
War benevolence	—	—	75,000	75,000
Dividend	775,000	852,000	1,017,000	1,150,000
Dividend, per cent.	10	11	12	12½
Carried forward	26,000	35,000	39,000	59,000

The share capital now stands at £10,000,000, the difference between this amount and £9,200,000 given in the table only ranking for dividend from July 1st, 1917. In addition, the loan debt reaches £5,274,000, and the mortgage debt £135,000. The credit at the company's bankers is stated to be £5,575,000, as compared with £6,680,000 in 1915-16, and £4,531,000 in 1914-15, whilst the advances made to the Berlin Electricity Works Co., the A.E.G. High-speed Railway Co., and other undertakings raise the total outstanding credits to £10,710,000, as against £10,010,000 in the preceding year. It is further mentioned that all new machinery, plant, patterns, &c., have been entirely written off, as in previous years. In conclusion, the report gives particulars of the company's investments, and refers to the transfer to the State of the interests held in the Electro Works Co.

French Companies.

The Société l'Eclairage Electrique reports net profits of £190,000 for the year ended on June 30th, 1917, as against £146,000 in the previous year. It is proposed to distribute 12s. per share, as in 1915-16.

The Compagnie Parisienne de l'Air Comprimé reports net profits of £37,000 for 1916-17, as contrasted with £63,000 in the previous 12 months. As the compressed-air business resulted in a deficit, no profits would have been realised had it not been for the return received from the settlement of accounts with the Union des Secteurs and from investments. The dividend in 1915-16 was at the rate of £1 4s. per share, and it is assumed that the rate for the past year will be 14s. 5d. per share.

The directors of the *Société Industrielle des Téléphones* report gross profits amounting to £373,000 for the year ended on June 30th, 1917, as compared with £260,000 in the preceding year. After deducting general expenses, interest on loans, and setting aside £100,000 for depreciation, as against £60,000 in 1915-16, the balance permits of the payment of a dividend of £1 12s. per share, as contrasted with £1 4s. and 12s. per share in the two previous years respectively. The sum of £64,000 has been placed to the contingency fund, and £30,000 to the legal reserve fund.

The report of the *Société d'Electro-Métallurgie de Dives* for 1916-17 states that new workshops were erected for Army purposes, and, apart from these installations, the greatest work undertaken related to the diversion of the sources of the Val au Loup and of the Caudemuche. As net profits the accounts show the sum of £223,000, as compared with £231,000 in the preceding year, and a dividend of £2 8s. per share has been declared for 1916-17. The reserve fund has received an addition of £104,000, thus raising it to £240,000.

The Société Anonyme Electro-Métallurgique (*Procédés Paul Girod*) reports that the works were actively engaged in 1916 not only in the distribution of energy for the Aciéries Paul Girod as well as in the district of Lyons served by the Société Hydro-Electrique de Lyon, but also in the production of special alloys. After providing for depreciation, the accounts show net profits amounting to £281,000, as compared with £59,000 in 1915. The tax on war profits absorbs £172,000, and the balance permits of the payment of a dividend of £2 per share. At the recent meeting a proposal was confirmed for amalgamating the company with its subsidiary —the Compagnie des Forges et Aciéries Electriques Paul Girod. The transaction is to take place this year, after the latter's capital has been increased for the purpose of effecting an interchange of shares.

Fraser & Chalmers, Ltd.—For the year ended June 30th last the profit, after providing for all expenses and depreciation, and after making provision for special taxation, was £36,174, as compared with £24,669 in the previous year. The works have been fully employed, and an increased output has been obtained. The results show improvement, notwithstanding the heavy increases in the cost of material and labour, and the difficulty of obtaining sufficient supplies. The merchandise business in South Africa has also been on a larger scale, in spite of freighting difficulties, and the results of the trading there and at the other branches of the company have been satisfactory. The directors recommend a dividend of 5 per cent., less tax, on the ordinary shares, and after transferring £20,000 to the reserve account (increasing it to £100,000) to carry forward the balance of £16,773.—*Financial Times.*

Tata Hydro-Electric Power Supply Co., Ltd.—The great success with which the introduction of electric power from the generating station on the Ghats is being developed in Bombay is revealed by the report of this company for the half-year ending June 30th. The company paid dividends of 7 per cent. per annum, both preference and ordinary shares, for the second half of last year. For the half-year just ended the directors recommend a further 7 per cent. per annum for preference shareholders, and a further 8 per cent. per annum on ordinary shares. The current now being supplied to motors in Bombay amounts to 48,000 H.P. The whole undertaking has been working most satisfactorily. Thirty-six mills are receiving power, and only the difficulties arising from the war prevent development being more rapid. Good progress has been made with the preparation of the new lake at Shirawata above the Ghats for the supply of additional water to the generators, and two-thirds of the new dam there has been completed.—*Indian Engineering.*

Companies Struck Off the Register.—The following companies have been struck off the Register, and are accordingly dissolved :—

Advisory Engineers' Corporation.	Midland Magneto Co.
All-British Electrical Co.	Fletcher's Electric Fittings.
Alphons Custodis Chimney Construc-tio	Krupka & Jacoby, Ltd.
Anti-German League.	Magneta Time Co.

Brazilian Traction, Light & Power Co.—Quarterly dividend of 1½ per cent. on the fully-paid cumulative preference shares.

Western Telegraph Co., Ltd.—First quarterly dividend, 3s. per share, free of tax, for the year ending June, 1918, being at the rate of 6 per cent. per annum.

United Wire Works, Ltd.—For the year ended September 30th, after providing for depreciation, bad debts, and excess profits duty, the credit balance is £14,036. Dividend, 7½ per cent. on ordinary shares, free of income-tax, £1,500 to general reserve, leaving £3,736 to carry forward.

Adelaide Electric Supply Co., Ltd.—A final dividend on the ordinary shares of 7 per cent., tax free, is announced, making 12 per cent., tax free, for the year.

Melbourne Electric Supply Co., Ltd.—Final dividend on the consolidated ordinary stock of 5 per cent., tax free, making 10 per cent., tax free

Pollock & Macnab, Ltd.—A petition for confirming the reduction of capital from £60,000 to £50,000 has been presented.

Globe Telegraph & Trust Co., Ltd.—Quarterly dividend, 2s. per share on the ordinary shares, free of tax.

Provincial Tramways Co., Ltd.—With the final dividend and bonus now announced, the total distribution on the ordinary shares for the year is 10 per cent.

Cape Electric Tramways, Ltd.—Dividend, 5 per cent., less tax.

STOCKS AND SHARES.

Tuesday Evening.

Had these been ordinary times, the quietude such as the Stock Exchange markets are experiencing would have been attributed to the advent of Christmas, but as this is scarcely a reason which can be advanced in war-time, members of the House put down the somewhat lifeless condition of markets to the Russian developments, to the War Bonds campaign, and to the news of a slight set-back on the Western Front. Prices keep steady in most departments, and, having regard to the paucity of business, to say nothing of the claims of the Government borrowings, it is a little surprising that the general strength should be so well held. There is less gambling going on, which is a good thing, but it has the effect of causing markets to appear dry and inanimate.

The home railway position has not been improved by the settlement of the latest strike. Prices gave way on the trouble which appeared imminent, and they have not recovered from the loss which they then sustained, notwithstanding the compromise arrived at between employers and employed. It is assumed that the greater part of the increased wages bills will have to be footed by the Government, *i.e.*, the country, and that the companies themselves will bear but a small proportion of the extra burden laid upon the industry by the latest all-round rise in wages. People, however, look ahead, and are disposed to wonder what will be the position at the end of the war, when the companies will presumably re-assume control of their own affairs, and when there will be no Government subsidy to help meet the increased costs of working. It is held accordingly that every rise in costs stores up future difficulty for the railway companies, and adds to the reasons why investors should seek fields other than home railway stocks for the employment of their money. Undergrounds are concerned indirectly by the broad considerations which govern British railway working, and the stocks are heavy with the rest.

The most active feature of the markets with which we deal is furnished by another jump in American Marconis. The price has strengthened 26s. 3d., and has been steadily rising from a level nearly 10s. lower down. As we have already indicated, the buying comes principally from the North of England, where rumour credits inside information with news of an important contract just concluded by the American Marconi Co., and optimists look for the price to go well over 30s. It may be well to lay accent on the word optimists. The parent shares are practically unchanged, though the strength of Americans reflects a little brightness to Canadians, these hardening to 11s. 9d. Marines are also a good spot at 52s.; and this section of the industrial market is one of the few strong spots.

Anglo-American Telegraph Preferred weakened a trifle, but the cable list as a whole is strong, and the monotonous complaint is reiterated that it is easier to sell than it is to buy. Some people are talking of the possibility of another increase in the dividends of the Western and Eastern groups, with its corollary of a rise in the Globe dividend. Speaking without intimate knowledge, this seems to be looking rather far ahead, because, with the possibility which has to be faced of further taxation, it can hardly be expected that such conservative boards as these which control the affairs of the cable companies would increase dividends, save in very exceptional circumstances, and, moreover, rates have already been advanced once since the outbreak of the war.

Western Telegraphs are ¼ better, and so are China shares. The usual quarterly dividends on Globe ordinary and preference are just declared. Great Northerns are flat, a drop of 50s. occurring on a little pressure to sell. Cuba Submarines are good, with a 5s. rise. Oriental Telephones have reacted. Automatic Telephone ordinary are better at 21s. 3d.

City of London Electric ordinary rose ¼ to 13¼, and the remainder of the list keeps very hard. Manufacturing issues are somewhat irregular. General Electric ordinary are 20s. up at 20¼. India-Rubbers gained ¼ at 14¼. Electric Construc-

tions have recovered their dividend deduction. Brush ordinary improved to 28½. British Aluminium show a small rise at 32s. 6d. On the other hand, Westinghouse preference have receded to 56s. 3d.; Babcocks are the turn easier at 64s. 6d. Edison Swan keep steady at 26s.

The Adelaide Electric Supply Co. declares a final dividend of 7 per cent., making 12 per cent., free of tax, for the sixth successive year, and the Melbourne Co. is to pay 5 per cent., making 10 per cent. (also tax-free) for five years running. In spite of these excellent results, Melbourne ordinary has fallen 3 points to 170. Adelaide ordinary are not quoted on this side. The 6 per cent. preference stand at 4¼. Anglo-Argentine First preference weakened to 2 15/16 on the incessant labour alarms in the Republic. Mexican issues are flat. The Second Mortgage bonds of the Light & Power Co. have dropped to 26½. Rio Seconds are easier at 76. Georgias fell ½ to 13. British Columbia 4½ per cent. debenture at 58 is 2½ up, though the preference is 2 points lower at 42½.

The rubber market remains lifeless, and the fall in the price of the material to a little below half-a-crown per lb. led to a fresh bout of profit-taking. Rubber is out of favour for the time being. There is no speculation going on, and the buyers of the earlier part of the year are now devoting their financial energies to shares which offer more scope for immediate profit. The base-metal markets are better, more especially that for tin shares, where a further record attained by the metal itself has had the effect of bringing in buyers for West Africans, although the home products of Cornwall are still neglected. The armament group has given way, and there is not so much going on in iron and steel shares generally, the decline in activity spelling, as usual, a slight reaction in quotations.

SHARE LIST OF ELECTRICAL COMPANIES.

	Dividend 1915.	Dividend 1916.	Price Dec. 4, 1917.	Rise or fall this week.	Yield p.c.
Home Electricity Companies.					
Brompton Ordinary	10	9	6½	—	£6 18 6
Charing Cross Ordinary	5	5	4½	—	5 17 8
do. do. 4½ Pref.	4½	4½	8¾	—	6 13 4
Chelsea	4	3	2¼	—	6 9 1
City of London	8	8	12½	+ ⅛	6 0 9
do. do. 6 per cent. Pref.	6	6	10½	—	5 18 6
County of London	7	7	11	—	6 7 3
do. 6 per cent. Pref.	6	6	10½	—	5 18 5
Kensington Ordinary	7	6	6⅞	—	5 11 7
London Electric	3	3	1	—	Nil
do. do. 6 per cent. Pref.	6	4	3½	—	5 6 8
Metropolitan	5	5	3½	—	4 12 4
do. 4½ per cent. Pref.	4½	4½	3⅝	—	7 4 0
St. James' and Pall Mall	8	8	7	—	5 14 6
South London	5	5	3	—	6 13 4
South Metropolitan Pref.	7	7	21/6	—	6 10 6
Westminster Ordinary	7	7	6⅞	—	5 5 8
Telegraphs and Telephones.					
Anglo-Am. Tel. Pref.	6	6	96½	— ½	6 4 8
do. Def.	33/6	1¼	35⅛	+ ⅛	6 8 4
Chile Telephone	8	8	7⅞	—	5 11 4
Cuba Sub. Ord.	5	7	9½	+ ¼	*7 11 4
Eastern Extension	8	8	14½	+ ⅛	*5 7 7
Eastern Tel. Ord.	8	8	149½	—	*5 7 0
Globe Tel. and T. Ord.	7	7	13½	—	*5 1 10
do. Pref.	6	6	10½	—	5 17 1
Great Northern Tel.	22	24	96½	—2½	6 11 6
Indo-European	13	13	52½	—	6 3 10
Marconi	10	15	8½	—	4 12 4
Oriental Telephone Ord.	10	10	8½	— ⅛	3 4 0
United R. Plate Tel.	8	8	6½	—	*5 18 6
West India and Pan.	6d.	6d.	1⅛	—	*3 9 6
Western Telegraph	7	8	15½	+ ⅛	*5 5 10
Home Rails.					
Central London, Ord. Assented	4	4	60½	—	6 12
Metropolitan	1	1	22½	— ½	4 9 0
do. District	Nil	Nil	18½	—	Nil
Underground Electric Ordinary	Nil	Nil	1½	—	Nil
do. do. "A"	Nil	Nil	6/0	—	Nil
do. do. Income	6	4	81½	— ½	*4 18 2
Foreign Trams, &c.					
	Dividend 1915.	Dividend 1916			
Adelaide Sup. 6 per cent. Pref.	6	6	4⅞	—	6 3 1
Anglo-Arg. Trams, First Pref.	5½	5½	21⅜	— 1/16	9 7 4
do. 2nd Pref.	5½	—	2½	—	—
do. 5 Deb.	5	5	67xd	—	7 9 3
Brazil Tractions	4	4	45	—	—
Bombay Electric Pref.	6	6	9⅞	—	6 3 1
British Columbia Elec. Rly. Pfds.	5	5	42⅜	—2	11 15 4
do. do. Preferred	Nil	Nil	30	—	Nil
do. do. Deferred	Nil	Nil	28	—	Nil
do. do. Deb.	4½	4½	58	+2½	7 6 7
Mexico Trams 5 per cent. Bonds	Nil	Nil	42	—	Nil
do. 6 per cent. Bonds	Nil	Nil	85	—1	Nil
Mexican Light Common	Nil	Nil	52½	—	Nil
do. Pref.	Nil	Nil	31	—	Nil
do. 1st Bonds	Nil	Nil	40½	—	—
Manufacturing Companies.					
Babcock & Wilcox	15	15	8⅞	— 3/32	4 11 8
British Aluminium Ord.	7	10	1⅝	+ 3/32	6 9 1
British Insulated Ord.	17½	20	8	—	6 13 4
British Westinghouse Pref.	7½	7½	2⅛	— 1/16	5 6 4
Callenders	20	20	14½	—	6 18 0
do. 5 Pref.	5	5	4½	—	6 1 8
Castner-Kellner	22	10	8⅞	—	5 16 3
Edison Swan, fully paid	—	—	2½	—	Nil
do. do. 4 per cent. Deb.	4	4	74½	—	5 7 5
Electric Construction	7½	7½	1 3/16xd	+ 3/32	6 6 4
Gen. Elec. Pref.	5	5	10⅜	—	6 13 0
do. Ord.	10	10	20½	+1	4 18 9
Henley	25	25	18½	—	7 18 8
do. 4½ Pref.	4½	4½	4	—	5 12 2
India-Rubber	10	10	14½	+ ½	*6 18 0
Telegraph Con.	20	20	41½	—	*5 15 7

* dividends paid free of income-tax.

MARKET QUOTATIONS.

It should be remembered, in making use of the figures appearing in the following list, that in some cases the prices are only general, and they may vary according to quantities and other circumstances.

Wednesday, December 5th.

CHEMICALS, &c.		Latest Price.	Fortnight's Inc. or Dec.
a Acid, Oxalic	per lb.	1/6	..
a Ammoniac Sal	per ton	£75	..
a Ammonia, Muriate (large crystal)	,,	£58	..
a Bisulphide of Carbon	,,	£20	..
a Borax	,,	£28	..
a Copper Sulphate	,,	£66	..
a Potash, Chlorate	per lb.	2/6	..
a ,, Perchlorate	,,	2/-	..
a Shellac	per cwt.	£17 10	£4 inc.
a Sulphate of Magnesia	per ton	£16	..
a Sulphur, Sublimed Flowers	,,	£35	..
a ,, Lump	,,	£26	..
a Soda, Chlorate	per lb.	10½d.	..
a ,, Crystals	per ton	12½/-	..
a Sodium Bichromate, casks	per lb.	..	..
METALS, &c.			
c Brass (rolled metal 2" to 12" basis)	per lb.	..	..
c ,, Tubes (solid drawn)	,,	..	..
c ,, Wire, basis	,,	..	..
c Copper Tubes (solid drawn)	,,	1/6½ to 1/7	..
g ,, Bars (best selected)	per ton	£147	£3 dec.
g ,, Sheet	,,	£147	£3 dec.
g ,, Rod	,,	£147	£3 dec.
d ,, (Electrolytic) Bars	,,	£125	..
d ,, ,, Sheets	,,	£152	..
d ,, ,, Wire Rods	,,	£133	..
d ,, ,, H.C. Wire	per lb.	1/3½	..
f Ebonite Rod	,,	3/-	..
f ,, Sheet	,,	2/6	..
n German Silver Wire	,,	2/0	..
h Gutta-percha, fine	,,	6/10	..
h India-rubber, Para fine	,,	2/5½	1/- dec.
i Iron Pig (Cleveland warrants)	per ton	Nom.	..
l ,, Wire, galv. No. 8, P.O. qual.	,,	£42	..
g Lead, English Pig	,,	..	..
g Mercury	per bot.	Nom.	..
e Mica (in original cases) small	per lb.	6d. to 8/-	..
e ,, ,, ,, medium	,,	8/6 to 6/-	..
e ,, ,, ,, large	,,	7/6 to 14/- & up.	..
d Silicium Bronze Wire	per lb.	1/8½	..
r Steel, Magnet, in bars	per ton	..	..
g Tin, Block (English)	,,	..	..
n ,, Wire, Nos. 1 to 16	per lb.	3/10	1d. inc.

Quotations supplied by—

a G. Boor & Co.
c Thos. Bolton & Sons, Ltd.
d Frederick Smith & Co.
e F. Wiggins & Sons.
f India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd.
g James & Shakespeare.
h Edward Till & Co.
i Bolling & Lowe.
l Richard Johnson & Nephew, Ltd.
n P. Ormiston & Sons.
r W. F. Dennis & Co.

Electric Traction in Coal Mines.—In the United States to-day storage battery locomotives are being used in mines both for gathering service and for main haulage. As one of these "electrics" will do the work of three to eight mules, it displaces a large number of drivers, who can be more profitably employed at the coal face. The cost of hauling coal and ore with storage-battery locomotives is only about one-half what it costs to haul with mules or horses, and the mine output can be materially increased and the sanitary conditions improved by the use of the electric vehicle. The Electric Vehicle Section of the National Electric Light Association has collected some interesting data showing the actual savings of the miniature electric locomotives over mule haulage in mines.

The Madison Coal Corporation, one of the largest coal-mining corporations of the middle West, which strongly advocates the use of the electric locomotive in coal mines, based on actual operating experience, states that in addition to the money saving in ton haulage there is a remarkable financial economy in the prevention of injuries, for while mule drivers form only 5 per cent. of the entire working forces, their accidents amount to 26 per cent. of the whole number, and the cost in connection with them amounts to 34 per cent. of the total liability cost. It is found that the total monthly cost of maintaining four mules with drivers is $342.80; the tonnage gathered is 8,368 tons, and the cost, altogether with mules and drivers, per ton, is $·04096. The cost of maintaining a storage-battery locomotive one month is $175·70; the tonnage gathered is 8,900 tons, and the total cost including $·00125 for energy per ton is $·02099, showing a difference in favour of the locomotive of $·01997 per ton.

The Pocahontas Smokeless Coal Co., of West Virginia, is also successfully operating storage-battery locomotives. At this mine four cars each weighing 1,300 lb. empty, and 4,100 lb. loaded are hauled on each trip by one electric locomotive, on main entry, a distance of about 2,500 ft., including 1,200 ft. against 3 per cent. grade, 400 ft. against 2½ per cent. grade, and short grades of 5 and 7 per cent., all against the loads. To get out the 400 tons a day that this mine should produce, the mule haulage would cost $735 a month and battery haulage $306 a month, making the very substantial saving of $429 a month in favour of the "electrics." Furthermore, the maximum number of mules and cars allowed by the track conditions could not handle 400 tons a day. The upkeep on ties and track was quite considerable with the mule haulage, and is greatly reduced with the locomotives. It is estimated that in one year the "electrics" will save the cost of the whole installation, and at the same time increase the coal output by two-thirds.

DIESEL ENGINES AND THE WAR.

By "PULVERISER."

Those central-station engineers who have Diesel engines under their control are, at the present time, working under serious disabilities. Not only have they difficulty in obtaining the specially trained staff required, and in replacing defective and worn parts, but a serious situation has arisen with regard to fuel supply. There is undoubtedly a feeling that their efforts to do the best, or the seeming best, in the country's interest, are thwarted by authority.

Diesel engines were worked in this country until 1915 almost entirely on imported petroleum residue fuel oil. About two years ago it was considered to be desirable that a home-produced substitute should be found in order to reduce purchases abroad.

Experiments were commenced in order to test the practicability of using tar oils, which are by-products of gas manufacture. The Diesel Engine Users' Association encouraged these efforts, and inquired as to sources of supply. Several papers were read by experimenters and others who could assist.

About 12 months ago matters had progressed so far that certain suitable grades of tar oil were obtainable at reasonable prices. They could, however, only be used in engines having rather costly pilot ignition. Other engines could only use tar oils when running near full load. Invention was further stimulated, and six months ago comparatively simple alterations to pulverisers were developed, so that any Diesel engine could be commercially used on tar oil when running at from half to full load. The technical problem was solved, the supply of fuel was forthcoming, and alterations proceeded apace.

It appears, however, that the proposed increased use of tar oil attracted the attention of a Controller, and restrictions were imposed. Engine users could, however, in most cases show that the work was "war work," and there was no serious difficulty in obtaining licences. Lately, however, an alarming position has developed. The Controller recently allocated a fixed and inadequate annual allowance of tar oil for engine users, but *there is no restriction on the use of petroleum* fuel. In effect, Diesel engine users are told: "Use as much petroleum as you like; use shipping to bring it over, pay your money abroad, but do not use tar oil."

This has been followed up by a somewhat tantalising price control, fixing tar oil at about £4 10s. per ton, while petroleum has rushed up to £16 per ton. It would appear that only a very pressing national need for tar oil, for more important purposes than the supply of power for munitions factories, could justify this state of affairs, which is obviously very much in favour of the importer and against the home producer and user. If allowed to continue, it must result in heavy increases in charges for power to consumers.

This has evidently been dimly realised by the Controller, as a circular has been addressed to central-station engineers asking for a return of tar oil used in the first half of 1917, an estimate for the same period of 1918, and for details of stand-by steam plant. It is a characteristic feature of this circular that no figures are desired for petroleum fuel oil. The proposal underlying this last request is that Diesel engine users will be compelled by high prices of petroleum fuel and by the restriction on tar oil to shut down their Diesels and run their antiquated steam sets, so that the Controller will be able to point to reduced consumption of his particular commodity, which is apparently the one aim and object of a Controller. From the point of view, however, of national interest, the Diesel engine user is unable to understand the position. Tar oil can usually be obtained locally, or with a short railway journey. Fuel oil of all kinds has a producing value of from four to five times that of an equal weight of coal. The man power required for loading and unloading is much less than with coal. Diesel engines have for these reasons shown increasingly favourable results as the distance from sources of coal supply increases. In the South of England, where Diesels are plentiful, coal must come along the munition-congested routes and in the same direction, *i.e.*, North or West to South, causing further congestion. The Coal Controller and the railway authorities are unable to deal satisfactorily with the present traffic, yet Diesel users are asked to replace 1 ton of fuel oil by 5 tons of coal, and 10 to 20-mile journeys by 50 to 100-mile trips. It would be necessary to engage more stokers, coal trimmers, carters (for coal and ashes), use more water, and, in many cases, raise prices of electricity if the use of old steam plant in place of Diesel engines were brought about.

At present the general opinion is that the effect of the policy being carried out is directly contrary to the ideals we have been asked to keep in mind—reduction of overseas traffic, of transport and of labour, and economy in use of coal—and that the restriction on the use of tar oil is a direct encouragement to profiteering in petroleum.

It is felt that a short-sighted Controller has got to work on his own watertight compartment without consulting his *confrères* who control shipping, railways, coal, and man power. If these latter officials have been consulted, and if they state that, notwithstanding the obviously bad effects from the point of view of their departments, it is desirable to persist in encouraging the use of any and every form of fuel in preference to tar oil, there will be a cessation of opposition from Diesel engine users, and they will, no doubt, assist in every way in making the change.

GAS FIRING BOILERS.

By T. M. HUNTER, M.A., B.Sc.

(*Abstract of paper read before the* Institution of Electrical Engineers.)

(*Continued from page* 510.)

Drying and Cleaning Gas.—It is very important that the gas should be dry when burned. At any temperature from 0 deg. to 100 deg. C. gas will take up a known amount of water as vapour, and this amount can be found in an air-saturation table. If the gas has been cooled or washed in water, it is reasonable to assume that it is saturated with water to the amount corresponding to the lowest temperature to which the gas has been brought. As an example of the amount of water carried in this way, the author had recently to use, at 15 deg. C. and 55 deg. C. respectively, the two producer gases described in the foregoing table. The former gas carried under 2 per cent. by volume of water vapour, and the latter carried 15½ per cent. This vapour must all be heated when the gas is burned, and it not only lowers the flame temperature, but also is responsible for carrying to the chimney a large quantity of sensible heat.

To show the actual loss from this cause, let us assume that we have cleaned blast-furnace gas from the same furnace, in one instance at atmospheric temperature with 12 to 15 grammes per cu. metre of water vapour, and in the other instance gas saturated at 70 deg. C., carrying about 362 grammes per cu. metre. In both cases the gas is to be burnt under boilers with an excess of air of 25 per cent.

In the first case the combustion temperature of this gas when burnt with an excess of air of 25 per cent. is 1,294 deg. C., found by using the Le Chatelier formula.

Now take the gas at 70 deg. C. The combustion temperature is found to be 1,010 deg. C.

There is a drop of 284 deg. C. in the combustion temperature, which, of course, is a very serious matter. It is much more difficult to obtain complete combustion of this mixture of aqueous vapour and gas with an excess of air of 25 per cent. than if gas alone is dealt with. It is also a well-known fact that the efficiency of a boiler depends in the first instance on the initial temperature of combustion, and if the latter is lower the efficiency of the boiler is certain to decrease. The evaporation per sq. ft. of heating surface is certain to be considerably smaller if wet gas is used than with dry gas.

We have next to consider the effect of the water vapour on the efficiency of the boiler. The loss through waste heat for dry gas would be 21 per cent of the total value of the gas, and for wet gas 29.8 per cent. In other words, the presence of the water in the gas will cause an unavoidable and irredeemable loss of 8.8 per cent., in addition to the loss by the reduced flame temperature. Assuming in both cases 5 per cent. loss through radiation and conduction, the actual efficiency for dry gas would be 74 per cent., and for the wet gas 65.2 per cent., which is equivalent to a drop in the output obtainable from the same quantity of gas amounting to 12 per cent.

So far as regards the efficiency, but it will also be worth while to consider the evaporation obtainable in both cases, assuming that the boiler is working on its maximum load, that is to say that the boiler flues pass the maximum quantities of gas and air which the chimney draught can convey

at the most favourable position of the damper. In the case of a 30 ft. × 8 ft. Lancashire boiler, with a dry gas under the above described circumstances the highest possible evaporation is 6,000 lb. of water from and at 212 deg. F. At 70 deg. C. each cubic foot of gas carries 0.0228 lb. of water, and at maximum load the evaporation works out at 4,725 lb. from and at 212 deg. F.

The simple presence of water in the gas can, under otherwise absolutely equal conditions, result in:—

1. A drop of efficiency of nearly 9 per cent.
2. A drop in evaporation of more than 21 per cent.
3. The loss due to lower flame temperature, which the author has not attempted to calculate.

It is evident that an engineer who has to specify a producer plant, or a gas-cleaning plant, where washing of the gas is part of the process, should take care to specify the maximum amount of water vapour allowable in the gas supplied.

Contrary to a frequently expressed opinion, the author does not believe that the dust in itself impairs seriously the heating value of blast-furnace gas; and the uncleaned gas has the advantage that it contains the sensible heat. The dust, however, may seriously affect the efficiency of the boiler. If two Lancashire boilers are run side by side, the one on cleaned and the other on uncleaned blast-furnace gas, it will be found that at first the results as regards both evaporation and efficiency are about the same. Soon dust will start to accumulate in the boiler flues, and as this dust is an insulating agent it will impair both the evaporation and the efficiency. After four or six weeks the dust accumulates in such large quantities that the evaporation falls and combustion may even take place partly in the stack instead of under the boiler. Where Lancashire boilers are to be fired, it will therefore generally pay to install a gas-cleaning plant, even at the expense of the sensible heat which is lost in the cleaning process.

Conditions are much more favourable with water-tube boilers, as with these it is often possible to clean the tubes without stopping the boiler. If liberal use is made of the steam lance, the proposition to put in a cleaning plant will certainly not be such a favourable one as in the case of Lancashire boilers.

The cheapest plant is not worth having, unless it fulfils the following conditions:—

1. The gas must be clean.
2. It must be dry, and this is even more important than the cleanness.

In some cases where the gas can be cooled to a temperature of 80 deg. C. without water injection, and where the ores contain only a small percentage of moisture, it is possible with a dry cleaning plant to obtain a dry, hot gas; whereas, where wet cleaning processes are used, or where water is injected for the purpose of cooling the gas, the gas is saturated and this water has to be eliminated.

So far as the author can discover, the cost of cleaning gas, inclusive of all charges, is about 2d. per 35,000 cu. ft., and is practically the same whether the wet or the dry process is used.

The sensible heat in blast-furnace gas per cubic foot is approximately as follows:—

Temperature of gas, deg. C.	200	250	300	350	400
Sensible heat, therms per cu. ft.	7	9	11	13	15

As cold blast-furnace gas varies from about 90 to 110 therms per cu. ft., this sensible heat is a large percentage of the total heat of the gas. Firing water-tube boilers with properly designed burners, and using the steam lance, say, twice a day to clean the tubes, the efficiency with uncleaned gas is certainly within 10 per cent. of the efficiency with cleaned gas—probably within 6 per cent. On the other hand, with Lancashire boilers the average efficiency over four or six weeks with uncleaned gas is very considerably lower than with cleaned gas.

The decision as to whether it will pay to clean gas must therefore be made for each case separately, and depends on the peculiarities of the gas and of the dust, as well as on the kind of boilers used.

Heat Transfer.—Gaseous fuel as usually burned does not give the intense local heat and the heat-radiating surface of the coal fire. Rather, the problem is that of a very hot gas which is cooled gradually as it travels through the boiler. It is like the problem of a coal-fired boiler with the fire-grate entirely outside.

The transfer of heat through a steel wall from hot gases to water consists of three parts—transfer of heat from gas to metal, transfer of heat through metal, transfer of heat from metal to water. The resistance to the transfer of heat in the second and third parts is exceedingly small when compared with the resistance to the transfer of heat from gases to metal. It is calculated for one case that the resistance to transfer of heat from gas to metal was 622 times the resistance to heat passing through the steel. This shows that the advantage to be gained by fitting, say, copper tubes instead of steel would be very small indeed. Again, the transfer from metal to water, if the metal has a clean surface, is also negligible compared with the gas-metal transfer. If, however, the metal carries scale on its surface the case is very different. Scale ¼ in. thick, assuming the scale to have the same conductivity as plaster of Paris, of which the specific resistance to the conduction of heat is 108 times that of iron, would add resistance to heat transfer equal to 18 per cent. of the resistance of transfer from gases to steel.

The problem of finding the most satisfactory boiler for gas firing is to be solved by the boiler which abstracts the heat most successfully from the hot gases passing. There are several lines along which improvements can be made.

The first is to increase the surface exposed to the hot gases by fixing projecting pieces inside the fire tubes, to increase the heated surface.

The second method depends on the fact that a square foot of heating surface at right angles to the gas flow is about eight times more effective than a similar area parallel to the gas flow—at ordinary velocities of gas. Deflectors or retarders are put into the boiler so as to cause the gases after they have been fully burned to impinge on the tubes as directly as possible.

A third method, and probably the one most commonly used, is to put surfaces of brick or other refractory material in the boiler in such a way that the flames play upon them. These surfaces are raised to a high temperature and transfer the heat by radiation to the boiler tubes. Such surfaces, in order to give the greatest effect, must face the boiler tubes squarely, and must be as near as possible to these tubes.

The transfer of heat by radiation becomes much more rapid in proportion as the difference between the temperatures of the two bodies concerned increases. This shows the necessity of raising our radiating surface to the highest possible temperature; and this again points to the use of the highest possible gas or air pressure in our burners in order to shorten the flame and make it more intense.

A fourth method depends on the theory that the difficulty of heat transfer from gas to metal is caused by a thin layer of cooled gas, which adheres to the surface of the metal and acts as a non-conductor. The stream of hot gases is made to scour very rapidly the surface of the tubes, and in this way the cooled gas is swept away and fresh hot gas is constantly applied. Very rapid heat transfer has been obtained by this means.

The author has had no experience with the Bonecourt boiler, but it is claimed by the makers that the heat is taken out of the gas by means of surface combustion on blocks of refractory material in the tubes, and that the heat is transferred by means of radiation from this material. Whether or not there is any surface combustion in the process as carried on in their latest boilers, the author thinks it likely that the high velocity of the gases through the tubes, in close contact with the walls and heating the refractory blocks, may be sufficient to account for the evaporation per square foot claimed. The suction required—16 in. water-gauge for the larger evaporations, equivalent to a velocity of about 250 ft. per second—would seem to bear this out. Unfortunately, it is a costly matter to get these high suctions for the very large volumes of hot gas with which we have to deal in boiler firing.

Each of these methods involves either the use of power or the insertion of some obstruction in the boiler. Boiler users object to have any kind of brick erection inside a flue, as it may burn away and require renewal, and it must be removed to clean and inspect the flue. The author considers that for existing boilers the method of increasing the heating surface by the use of some kind of metal fitting in the flues is the one least open to objection. Power for forced draught or suction is a charge against the boiler, and its cost must be deducted from the efficiency of the boiler. To put the gas—or air—under 2 in. pressure, in the case of blast-furnace or producer gas, requires power which would only reduce the boiler efficiency by 1½ to 2 per cent., whereas the additional efficiency attained may be from 10 to 20 per cent.

Types of Boilers.—Lancashire boilers are used very largely, and have to be utilised in the best way possible for gas firing. It is a pity that three-flue and five-flue boilers are not more often used, as they not only give a larger heating surface, but also allow of smaller volumes of gas being burned in each flue. With smaller volumes of gas it is easier to burn the gas with a small excess of air. A disadvantage of the Lancashire boiler when gas-fired in any of the usual ways is that the fall of temperature in the gases from one end of the flues to the other is not sufficient to set up good circulation of the water, as is done by the intense local heat of the fire when the boiler is hand fired. In spite of all that is said against gas-fired Lancashire boilers, they will continue to be successfully and economically used. The author has experience of regular evaporations of over 9,000 lb. per hour from and at 212 deg. F. from ordinary 30 ft. × 8 ft. boilers, both with producer gas and with blast-furnace gas, which is far higher than what we should expect from a water-tube boiler.

The author's idea is to have a boiler with a considerable number of smaller tubes, forcing the gas to burn at the highest possible temperature in each, and to have no obstructions in the tubes, and no mechanical suction. Such a boiler, properly insulated, would give at least as good results as the best water-tube boiler.

Wherever high-pressure boilers are to be installed, there is little doubt that water-tube boilers will be chosen if the available feed-water is soft enough and can be suitably treated. It is important that sufficient combustion space should be provided for the huge volumes of gas, so that the gas may be fully burned before passing through the tubes. External combustion chambers should be avoided as causing unnecessary

losses by radiation and conduction of heat, and because the highest temperature is not attained in the immediate vicinity of the tubes.

A good boiler should evaporate about 80 per cent. of its load in the first bank of tubes, 15 per cent. in the second, and 5 per cent. in the third. The third bank is thus practically an economiser, and this accounts for the fact that the maximum evaporation of water-tube gas-fired boilers per square foot of heating surface is usually only 5½ to 6 lb. per hour. In a large Stirling boiler fired with coke-oven gas and evaporating 5½ lb. per square foot of heating surface, the temperature of the steam was 290 deg. C., the temperature of the gases leaving the boiler was only 238 deg. C., and the temperature of the feed water was 55 deg. C.

When judging a boiler, it will be safe to take the results obtained from coal-firing, as we can be certain that if the same boiler is fitted with good furnaces and arranged for gas-firing it will do somewhat better. In any case, where gas-firing is concerned the choice of the right combustion arrangement is much more important than the choice of the best boiler. Up-to-date boilers do not differ in their results when coal-fired, and, when the same stokers are chosen, by more than 5 per cent. at the outside; whereas, when it comes to gas-firing, one combustion arrangement can easily do 50 per cent. better than another.

Another important question is the arrangement of superheaters in gas-fired boilers. When gas-fired boilers are arranged for hand-firing and gas-firing, the nozzles of the burners are, as a rule, too near the superheaters, so that in a good many cases the superheat imparted to the steam is too large. Superheated steam pays as long as the superheat is not more than 85 deg. C. The heat added to the steam over and above that is practically lost, unless the steam is carried a very long way and loses part of the superheat in transit. It is, therefore, essential that the distance between the superheaters and the nozzles of the burners should be if possible more than 10 ft., so as to ensure that the superheater does not come into contact with the burning gas.

The ideal boiler for gas-firing has not yet been developed. There is no doubt that a water-tube boiler which is arranged so that the gas can be fully burned before passing through the tubes, and where the gas stream is kept at right angles to the line of the tubes by careful baffling, is the best boiler we have so far. To get higher outputs from such a boiler per square foot of heating surface is a matter calling for more rapid combustion of the gas, with more intense flame temperature, and this can easily be arranged where required.

The author has never come across a water-tube boiler with small diameter tubes, such as, for example, the Yarrow boiler, gas fired. It seems probable from the theoretical point of view that the Yarrow boiler would give excellent results. As the tubes are only about 1 in. diameter, the proportion of heating surface touched by the gases, to the wetted surface of the tubes, is much larger than in the usual forms of water-tube boilers. As also the tubes are only about ¼ in. apart, the waste gases must pass between them at a high velocity. For these reasons the author would expect to get a high output and economical results with this type of boiler.

(To be concluded.)

Discussion in London.

The discussion was opened by Mr. C. P. Sparks, who welcomed a paper on what was a new subject to them. The author dealt with gas and how to handle it; he wished that it had dealt rather with the sources of gas, which was the first matter of importance to the electrical industry. In burning solid fuel for steam generation, all the volatiles were lost, and it was recognised that the method must be altered; the chemical industry was dependent on coal by-products. Considering coal distillation, in coke production gas was a by-product, and in gas production, coke was the by-product; there was also low-temperature distillation, in which gas and other by-products were obtained. He asked were they to put their stations at the coke ovens or at the gas works, or wait the development of further processes. Their problem must be considered from the power engineer's point of view, which was that of securing heat units; it must be approached from a new standpoint. The Fuel Research Committee were considering how best to use fuel so as to meet all the objects in view, and the matter was also being investigated by important commercial undertakings. The question for electrical men was how they were going to get the gas. Coke manufacture took place primarily at the pits, and in most cases water was not abundant there, so that this crippled the use of steam turbines in such a locality; in addition, the question of transmission was involved. To utilise products of existing gas works would decentralise power production, instead of concentrating it, as desired.

Mr. W. B. Woodhouse emphasised the importance of a steady gas pressure for successful gas firing. The point in gross and net calorific values was to know which was being used. He thought the author was optimistic in his estimate of 6,000 cu. ft. of gas per ton of coal for coke ovens, while the figures for blast-furnace gas were extremely high. The important question was how much gas was surplus after completing all processes (including blowing), and he estimated this as worth 1s. 6d. per ton of pig produced; in this country very few blast furnaces had any surplus, and it was difficult to get successful firing with a gas containing so much inert matter. If it were necessary specially to dry gas, it was a question whether it would pay.

Mr. E. W. L. Nichol said he felt that gas was too good for boiler firing, and the pressing need was the development of a furnace for burning coke on a large scale. As regards waste heat, with present practice gas-works coke was drawn from the retorts at 1,800 deg. F., and contained 13 per cent. of the heat used in making it; it was usually quenched in water, but there was no reason why it should not instead be dumped into a furnace, and the heat utilised at the gas works. The problem of conveying gas to a station of, say, 100,000 kw., was a huge one, some 23 million cu. ft. of 130-B.Th.U. producer gas per hour would be required; and ordinary coal gas was out of the question.

Mr. H. W. Kolle remarked that the use of blast-furnace gas was more difficult than would appear from the paper. Pressure variation was a serious question, also there was the difficulty of adjusting air supply to gas supply. The author's figure of 25 per cent. excess air with blast-furnace gas was too low; in practice it was usually 100 per cent. Where there was pressure variation in the main, the air was adjusted for the maximum pressure. It was not so easy to carry out a test on gas-fired plant using dirty gas, and he did not know of any case where means was provided for controlling pressure. He thought there was not much in cleaning gas, and felt that the whole matter required much further consideration. With producer and coke-oven gas, the pressure could be regulated, but he thought the author had given a wrong impression as to blast-furnace gas firing.

Mr. J. D. Paton urged electrical engineers to study the question of combustion; they must appreciate flame colour and make the utmost use of the CO gas, which was the heat giver. Some 25 million tons of coal were wasted annually, in the heap, lost in mains or in the mine, and our fuel authorities had not attempted to deal with this matter. A large part of this fuel was only suitable for distillation, and the coke would contain so much ash that it could only be used in a producer for gas making.

Mr. W. R. Cooper said the paper was valuable as an analytical one, and as, no doubt, gas-firing would come they must be prepared to use it. It was difficult to find the quantity of gas used in industrial processes, but if used for industrial firing they must know its quantity and heat value. He thought that in the future attempts would be made to make more use of radiant heat in gas firing; in the producer the efficiency would be improved by reducing the steam used. But the commercial future of gas-firing depended very much on the realisation of the value of by-products. Low-temperature coke could be best used in producers, and for this reason the low-temperature carbonisation processes were worth considering.

Mr. W. H. Patchell criticised the variation from practice of some of the author's figures. The question was whether coal could be more economically turned into electricity, and, with gas firing, it turned largely on the by-products. Coke was a difficult by-product to burn, and involved extra transport, and it would be advantageous to use it in producers for gas making.

Mr. J. H. Highfield said the discussion revealed the fact that there were numerous sources of waste heat, and it was clear that the latter must be used in the form of electricity, but this still left the problem of producing the major part of the energy which would be required, and of using some form of gaseous fuel in its production. It was difficult to get any figures to go upon; in a fair-sized steam plant one might get 900 units per ton of coal costing 20s. To obtain this by gas-firing would require 1¼ tons, costing on the same basis 25s., and if it were assumed that sulphate of ammonia and some tar were obtained as by-products valued at 10s., then the net fuel cost would be 15s., leaving 5s., which would about meet the extra financial charges. In the case of a gas engine of, say, 1,000 h.p., 900 units could be generated on .6 ton of coal, costing 12s.; by-products might fetch 5s., leaving 7s. as the net coal cost.

Mr. A. H. Dykes said we must utilise all waste heat in the future; we were now doing so in part. Then we had to consider the capital question of large stations. With gas firing this would involve the chemical and metallurgical industries, and therefore the form of gas would no doubt be decided for the electrical engineers, and they must therefore consider how to use any probable form of gas available. Figures were required; there was too much mystery attaching to the results now obtained. Special types of boiler would have to be designed to meet the conditions, and a subsidiary advantage would be the labour saving.

Mr. C. P. Taylor said the author showed 30 per cent. of the heat value thrown away in producer work, the only justification for which was the by-products obtained. High fuel costs would upset all calculations unless the price of sulphate of ammonia also went up. It was questionable whether it would be profitable in a small scheme to transmit electricity rather than gas.

Mr. L. B. Atkinson urged that too much stress must not be laid on the by-product value of sulphate of ammonia; they must look to oils and other chemical by-products. No one would use sulphate of ammonia if he could get nitrates (which

would be produced electrically), and would be available at a lower price per ton in more suitable form for agricultural purposes.

Mr. H. M. Sayers asked if any attempt had been made to clean gas by centrifugal methods?

The Author, in his reply, said he had not dealt with the manufacture of gas. Dry gas meant gas in which the moisture had been extracted by ordinary methods. The tendency was to put in cleaning plants for blast-furnace gas, which flattened out pressure variation, giving reasonable uniformity; some classes of gas must be cleaned or solidification of the dust would occur. With clean gas, economisers could be used without scrapers. It was difficult to substantiate figures for efficiency, but with a good boiler and economiser he would hope to secure an efficiency of 85 per cent. with coke-oven gas, and about 80 per cent. with clean blast-furnace gas. The efficiency of the Bonecourt boiler was probably due to gas velocity and radiation.

PARLIAMENTARY.

(*Concluded from page 526.*)

The following applications for powers are set out fully in notices published in the *London Gazette* for November 27th :—

Canvey Deep-Water Wharf and Railway.—New company to construct wharf, railway, dock, and other works; electric generating stations; working railway by steam or electricity; supply of electrical energy.

Yorkshire Electric Power Co.—New and further powers as to supply; obligations upon local authorities, companies, and others obtaining powers in future to take supply of energy in bulk from the company; provisions as to Joint Boards or Committees, &c.

Sheffield Corporation (Consolidation).—Various powers respecting tramways, trolley vehicles, and electric supply.

Shropshire, Worcestershire & Staffordshire Electric Power Co.—Various additional powers, extensions of existing powers, &c.

Doncaster Rural District.—Electrical Distribution of Yorkshire, Ltd., seeks a Provisional Order for supply in a number of parishes and townships in the rural district of Doncaster.

Gildersome.—Electrical Distribution of Yorkshire, Ltd., seeks a Provisional Order for electricity supply.

Luddenden Foot and Mytholmroyd.—Ditto.

Rotherham Rural District.—Ditto.

Hoyland Nether U.D.C.—Amendment of E.L. Order, 1912, extension of time.

Workington Corporation.—Provisional Order for electricity supply.

Sheffield Corporation.—Electric supply extension powers for urban districts of Handsworth and Dronfield and a number of parishes in other districts.

Clayton and Queensbury.—Electrical Distribution of Yorkshire, Ltd.—Provisional Order for supply in Clayton and Queensbury urban districts.

Thorne.—Electrical Distribution of Yorkshire, Ltd.—Provisional Order for supply in Thorne Rural District.

Guiseley and Menston.—Electrical Distribution of Yorkshire, Ltd.—Provisional Order for Guiseley U.D. and Menston parish.

The following notices appear in the *London Gazette* for November 30th :—

Gainsborough.—Application by J. Marshall, Gainsborough, for Electric Lighting Provisional Order.

Knottingley U.D.C.—Alteration, &c., of 1914 E.L. Order.

NEW PATENTS APPLIED FOR, 1917.

(NOT YET PUBLISHED.)

Compiled expressly for this journal by Messrs. W. P. Thompson & Co., Electrical Patent Agents, 285, High Holborn, London, W.C., and at Liverpool and Bradford.

17,005. "Electromagnetic force therapeutic generators." C. Graham. November 19th.
17,011. "Electric signalling apparatus." F. S. S. Wates. November 19th.
17,013. "Indicator, electric alarm, ignition, cut-off apparatus for lubrication systems of engines." A. J. Hill. November 19th.
17,014. "Electric commutators, &c." Soc. Anon. des Etablissements L. Blériot. November 19th. (France, November 20th, 1916.)
17,017. "Contact-breaking device for magneto ignition." G. A. Chailliey. November 19th. (France, June 5th.)
17,018. "High-tension ignition magnetos." G. A. Chailliey. November 19th. (France, June 5th.)
17,019. "Oil-cooled electrical transformers." T. R. Renfrew. November 19th.
17,044. "Permanent magnet motor meters." Landis & Gyr Akt. Ges. November 19th. (Switzerland, December 2nd, 1916.)
17,045. "Method of working refractory metals." Westinghouse Metal Filament Lamp Co. November 19th.
17,060. "Lighting devices for motor vehicles." Benjamin Electric, Ltd. November 20th. (U.S.A., November 27th, 1916.)
17,091. "Induction coils." M. A. Codd. November 20th.
17,111. "Arc lamps." P. W. Bidmead. November 20th.
17,136. "Means of adjustably connecting a magneto and gear-box to motor-cycle bracket." S. C. Poole & F. W. A. Smith. November 21st.
17,162. "Telephone instruments." H. Wilson. November 21st.
17,172. "Alternating electric current protective devices adapted to operate on reversal of current." British Thomson-Houston Co. & E. B. Wedmore. November 21st.
17,173. "Dynamo-electric machine." British Thomson-Houston Co. & A. A. Pollock. November 21st.
17,187. "Electric glow lamps." C. O. Bastian. November 21st.
17,211. "Electric incandescent lamps." Siemens & Halske Akt. Ges. November 22nd. (Germany, December 20th, 1916.)
17,218. "Electrical control systems." British Westinghouse Electric and Manufacturing Co. November 22nd. (U.S.A., November 22nd, 1916.)
17,221. "Sound-producers applicable to submarine signalling, &c." J. M. Ringquist. November 22nd.
17,224. "Dynamo-electric machine." C. L. Breeden, H. L. Cape & H. Lucas. November 22nd.
17,258. "Magneto compasses." C. F. Ryland. November 23rd.
17,277. "Rotary rectifier of alternating current." A. D. Macropoulos and C. D. Macropoulos. November 23rd.
17,292. "Electric batteries." A. A. Price. November 23rd.
17,296. "Test sheath joint for electric cable." C. J. Beaver, E. A. Claremont & A. F. W. Richards. November 23rd.
17,300 & 17,301. "Carbon brushes for dynamo-electric machines." C. Y. Knight, Morgan Crucible Co. & W. N. Wilson. November 23rd.
17,311. "Electric switches." E. L. Rankin. November 23rd.
17,320. "Deflectors for electric arc lamps, searchlights, &c." J. P. Yorke. November 23rd.
17,335. "Electric signalling systems." F. G. Bell, W. C. Davey and Sterling Telephone & Electric Co. November 24th.
17,339. "Electromedical apparatus." E. E. Greville. November 24th.
17,342. "Method of operating valves of internal-combustion engines by electrical energy." M. Tate. November 24th.
17,374. "Long-arm for overhead system electric tramcars." A. Senior. November 24th.
17,377. "Storage batteries." R. L. Smith. November 24th. (U.S.A., May 17th.)
17,379. "Ignition magnetos." E. Marelli & Co. November 24th. (Italy September 28th, 1916.)

PUBLISHED SPECIFICATIONS.

The numbers in parentheses are those under which the specifications will be printed and abridged, and all subsequent proceedings will be taken.

1916.

7,062. Magneto-electric Machines. H. Robinson. November 16th, 1916. (110,760.)
8,584. Method of and Apparatus for Electric Distribution for use with Ignition Systems. C. T. Mason. June 19th, 1915. (100,742.)
10,938. Electric Switch Controls. G. A. Fritsch. August 2nd, 1916. (110,768.)
15,177. Portable Electric Signalling Lamps. W. T. Coulson. (Cognate application, 5,394/17.) (110,592.)
15,187. Electric Transformers. British Electric Transformer Co. & T. R. Renfree. October 25th, 1916. (110,594.)
15,310. Electric Flashlamps. E. Nuttal. October 27th, 1916. (110,611.)
15,351. Interrupters for Ignition Systems. C. T. Mason. June 30th, 1915. (101,980.)
15,357. Electrolytic Gas Generators. I. H. Levin. December 20th, 1915. (102,933.)
15,365. Trolley Heads for Electric Tramcars. C. Svombo. October 27th, 1916. (110,612.)
15,398. Ignition Devices for Internal-combustion Engines. R. G. L. Markham. October 28th, 1916. (110,613.)
15,464. Igniters for Internal-combustion Engines. J. F. Alvord & W. B. Thompson. October 28th, 1915. (102,058.)
15,623. Means for Attaching Ignition Wires to Sparking Plugs of Rotary Aeroplane Engines. Gwynnes, Ltd., & H. Humphreys. November 22nd, 1916. (110,796.)
15,888. Stage Lighting. E. Booth & N. R. Booth. November 7th, 1916. (110,627.)
16,090. Electrically-operated Striking Device for Clocks. M. E. Pugh. November 9th, 1916. (110,629.)
16,155. Ignition Magnetos for Internal-combustion Engines. A. H. Boulton & J. H. Boulton. November 10th, 1916. (110,630.)
16,382. Electric Switchgear. H. W. Clothier and A. Reyrolle & Co. November 15th, 1916. (110,808.)
16,452. Mercury Breaks or Electric Interrupters. F. R. Butt & Co., H. F. Bigge & F. R. Butt. November 16th, 1916. (110,635.)
16,513. Ignition Dynamos. C. T. Mason. June 19th, 1915. (102,266.)
16,892. Telephone Instruments. International Electric Co. & H. E. R. Roose. November 24th, 1916. (110,640.)
17,003. High-frequency Signalling, particularly applicable to Wireless Telephony. Western Electric Co. November 29th, 1915. (102,500.)
17,998. Electric Batteries. J. M. Flannery. December 14th, 1916. (110,652.)
17,999. Electric Batteries. J. M. Flannery. December 14th, 1916. (110,653.)
18,661. Control Gear for Alternating Current Electric Motors. J. A. Steven & R. J. Gotterson. December 30th, 1916. (110,836.)

1917.

220. Apparatus for Electric Welding. T. E. Murray. January 12th, 1916. (103,293.)
1,017. Suspender for Electric Cables and the like. W. T. Henley's Telegraph Works Co. & R. Povey. January 20th, 1917. (110,848.)
1,490. Toy Electric Motor. A. C. Gilbert Co. April 18th, 1916. (105,742.)
2,093. Wireless Telegraph Apparatus. R. J. Thompson & J. Thompson. February 12th, 1917. (110,685.)
2,109. Means for Securing an Insulator to a Base Plate. Maschinenfabrik Oerlikon, February 12th, 1916. (104,177.)
2,701. Electro-deposition of Copper and Nickel from Solutions obtained from Ores. M. V. Garin. February 29th, 1916. (104,678.)
2,900. Electric Cable Connectors. Chloride Electrical Storage Co. & H. Dean. February 27th, 1917. (110,858.)
3,236. Electric Controllers and the like. G. Ellison & J. Anderson. March 5th, 1917. (110,862.)
3,464. Magneto-electric Machines for Ignition in Internal-combustion Engines. M. S. Conner. March 9th, 1917. (110,864.)
3,802. General and Electrical Joints. C. J. Beaver & E. A. Claremont. March 15th, 1917. (110,868.)
4,142. Electric Imitation Candles. C. Ammentorp. May 20th, 1916. (106,609.)
6,284. Electric Flashlights. M. H. Spielman & J. Corcos. May 3rd, 1917. (110,702.)
6,681. Electric Torches. R. Fallows. April 30th, 1917. (110,700.)
8,748. Electric Contact Breakers. F. H. Royce & Rolls-Royce, Ltd. June 18th, 1917. (110,891.)
9,182. Magneto Controlling Device enabling Internal-combustion Motors to be Started by Hand. July 1st, 1916. (107,761.)